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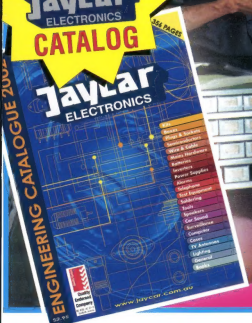

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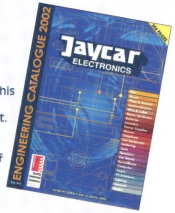

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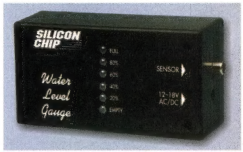

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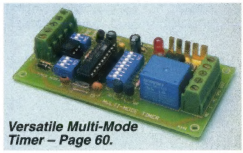

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PUBLISHER'S LETTER

Electronics in cars: the improvements keep on coming

This month, we have two short stories concerning continued developments in cars. Both involve the application of electronics and both aim to improve fuel economy, passenger comfort and so on. The Volvo development, involving the replacement of the starter motor and alternator with the "integrated starter generator" is particularly interesting, in that it is another approach to a hybrid motor vehicle like the Toyota Prius or the Honda Insight which were featured in our December 2001 issue.

In general, hybrid vehicles gain most of their fuel economy improvements because the internal combustion motor only runs when needed and does not run when the vehicle is stationary (ie, otherwise at idle) or running downhill.

However, when you look at the whole thing dispassionately, it is all "fiddling around the edges", isn't it? Few people are really concerned about fuel economy or "saving the environment". If we were, very few large 4-wheel drive recreational vehicles would be sold. Nor for that matter, would most of the large six and 8-cylinder cars be sold. Most people would contentedly drive around in small 4-cylinder cars which are perfectly capable of keeping up in today's traffic. Or they'd take public transport. Or walk! Perish the thought.

To take matters further, if there was a real drive to obtain seriously better fuel economy, there would have been a much bigger effort to eliminate the internal combustion engine from cars. Until that happens, the internal combustion engine and our continuing love affair with ever-more powerful cars will continue to be the limiting factors in "saving the environment".

Do we really care? Not really. I must own up myself. I like a big car – I don't like driving a little four-banger. And if in the future, all-electric vehicles become readily available, I still don't see myself driving something small and slow. I want space and I want some "oomph" when I push the pedal down. Most people are the same.

So is there any hope? Of course there is. Electric cars with heaps of performance will eventually become available. They will be silent, economical and they will be attractive to drive. But it is also a fair bet that they won't be battery-driven. They will still run on petrol, LPG or some other hydrocarbon fuel and they will have fuel cells to drive the electric motor.

Ultimately this is the only practical solution, short of governments making conventional cars illegal. That's not likely though, in democratic countries at least.

So is the fuel cell coming? Is it just a pipe dream? Indeed, it is not. Fuel cells are coming, although it might be 10 years before they become really practical in motor vehicles. Until that time, try to drive a little more economically. And we will bring you the stories on fuel cells in the months to come.

Leo Simpson

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SILICON CHIP MAILBAG

Ground plane antenna works well

I have recently completed the "Elevated Ground Plane Antenna" from the February 2001 edition of SILICON CHIP. Reception has improved greatly, compared with the "rubber duckie" and will soon be mounted up in the roof, mainly for use on the club's Sunday net.

There's a small trap for the unwary, myself included. Half-inch copper pipe in NZ has an internal diameter of 0.5-inch while the Australian counterpart has an *external* diameter of 0.5-inch. Calculations showed that the radiator would need to be 0.3-inch diameter, an unlikely purchase other than in copper pipe which would be from a coil and tricky to straighten. A friend was holidaying in Melbourne and brought back a piece of pipe which made things a lot easier. I couldn't buy a 110mm square of 1mm brass sheet (the minimum sale was half a sheet), so a piece of single-sided fibreglass PC board was used. Otherwise, it's made strictly to your design.

The demountable radials are a great idea, particularly when accessing the roof space. I used the club's MFJ antenna analyser to check the antenna. With the analyser connected directly to the PL259, the following frequency/SWR/Z (resistance) readings were noted: 144MHz-1.7/35; 145-1.4/35; 145.5-1.2/33; 146-1.03/32; 146.6-1:1/30; 147-1:1/30 and 148-1.2/25. These figures were obtained after the radiator had been shortened by 10mm. There's still a mismatch of 30-50 ohms but our net frequency is 146.575MHz and I've decided to leave things as they are.

On a general note, I'm pleased to see projects coming through where things have to be made but how popular they will be, only time will tell. I taught metalwork, woodwork and technical drawing for some years but the formal teaching of the practical subjects has all but gone here and, I believe, to some extent in Australia. A recent editor in "House and Home" magazine suggested people should go to night classes to retrain in these subjects.

I was sorry to see "Electronics Australia" fall by the wayside but you're doing a great job at SILICON CHIP. Keep up the good work. The antenna is a very good design and I enjoyed making it.

B. Toomey,
Bucklands Beach, NZ.

Comments on Veroboard

Your remarks concerning the use of Veroboard in the Motorcycle Alarm project, January 2002, to the effect that you "don't like it much" seem a little enigmatic. I assume the reason is that some constructors have difficulty in correctly locating the components and track breaks.

Personally, I prefer to use Veroboard for relatively simple circuits and would be delighted if electronics magazines produced a Veroboard version of all their projects where complex PC boards are not required. Producing a special PC board for something with less than a couple of dozen components seems rather superfluous to me. Unless there is some necessity to obtain very close track layouts or component packing, Veroboard is quite adequate for most circuits.

When constructing a circuit on Veroboard, I find it very helpful to draw a diagram of the component layout on a grid of dots which matches the holes in the Veroboard and then glue this on the top side of the board. To locate the position of each break in the tracks, I push a pair of map pins through the paper and the Veroboard holes underneath on either side of the required break. When the board is turned over, the location of the break is obvious and mistakes are virtually eliminated. A photocopy of a layout published in a magazine of course makes it even easier!

R. Hancock,
Port Elliot, SA.

Electric power history wanted

I was quite taken with the letter from Dick Smith in the January 2002 issue in which he suggested an article on the Australian 3-pin mains plug/socket.

I wouldn't mind seeing an article about our AC mains in general. Why do we have 240 volts and why do the Americans have 110? What scientific reason is there for either voltage? (Probably none.) Why do the American also have two-pin plugs/sockets and no earth wire? Why do the British Isles have about three different plugs/sockets for their 240VAC mains? Wouldn't one do? I also believe West-

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ern Australia has a slightly different voltage from the rest of the country. Do we know why this is?

I seem to recall that one of the electronics magazines did something along the above lines some years ago. It may have been in SILICON CHIP – I can't remember exactly. Perhaps you may consider an article on the AC mains around the world for the future. I, for one, would be interested in it.

B. Freeman,
Morphett Vale, SA.

More on Australian mains plugs

Following on the letter in March issue on how the Australian mains plug came about, it's an interesting question as to what happened to the original 3-pin design in the USA. I've only seen reference to it in US wiring and DIY books up until the 1950s. It was used only for 240V applications like ranges, driers, etc. Obviously it was meant to be incompatible with their conventional 120V 2-pin design (although as we know a slight twist to the pins with a pair of pliers will overcome that).

I should also point out that our/their 3-pin design was not the only one in use. There was, and still seems to be, an assortment of pin shapes and patterns for 240V use in the USA, without any standardisation. For example, the (240V) DEC PDP11 etc, computer equipment I've worked with has what looks like a modern US 3-pin plug but the blades are at right angles.

As for the US 3-pin 120V plug, it seems that this didn't become popular until the 1950s and then only for things like power tools. In fact, I can't recall having seen it at all in any of the old literature I've read prior to this time.

Things like washing machines were earthed directly to the closest water pipe. You could also purchase (and I have such one example) an adaptor to convert a 2-pin outlet to take a 3-pin plug. It's a Bakelite moulding with a 2-pin plug one side and the 3-pin socket on the other, with a short wire protruding, intended to be screwed under the cover plate screw of the outlet, the idea being that the earth return is via the metal outlet box and earthed conduit.

John Hunter,
via email.

Endorsement of editorial content

Keep up the great work on SILICON CHIP! Please don't change anything. However, as a suggestion, why not ask readers to submit a photo of their SILICON CHIP project in use, or maybe have a featured reader with all the SILICON CHIP projects that he or she has constructed? I liked the item in the January 2002 issue, on how a reader submitted a picture of his video scope.

It is good to see the high standard quality of work produced by the readers. In many instances, producing the case and the front panels can take almost twice as much time to make as the inner working parts of the project.

Recently I made the ±18V 1A power supply (SILICON CHIP, January 1988) from scratch, making the PC board, sourcing the parts, then making the front panel out of aluminium, powder-coating it, then using Letraset (rub on lettering) for all labelling and finally spraying on lacquer to prevent the letters from coming off.

It looks as though it has just come off a production line, with the difference being that it took almost 4 weeks to build as opposed to a production line making it in a few hours!

Attila Palotas,
via email.

Electronics Australia

Congratulations on picking up the EA flag. I first read "Radio and Hobbies" about 50 years ago and picked up much of my electronics knowledge from its articles. I was disappointed to see EA become a lifestyle magazine and SILICON CHIP has been the only thing to keep the electronics enthusiast satisfied.

The fact that you have elected to maintain the EA back issues, web page, etc is to be lauded. Others may have just cast the whole lot of history out with the rubbish. I appreciate the SILICON CHIP stance and hope that the SC/EA combination has a long and fruitful future.

Doug Rickard,
Coomera, Qld.

Deja vu with Diason vintage set

Well, was I delighted when I opened my February 2002 issue of SILICON CHIP? There it was, my Diason radio of 32V country lighting plant fame.

I dusted off the one I have and had a good look and rattled my memory banks – it is not quite the same as in the article. I believe this one has 6SK7 RF; 6A8 converter; 6SK7 first IF; 6SK7 2nd IF; 6AR7(?) detector/first audio; and a single 32L6 audio output – yes 32L6! An easy heater string arrangement and lots of selectivity.

In mine, there is another IF can above the 32V sticker in your photo on page 83. The cabinet and chassis is otherwise identical and I note a Rola 8H speaker, stamped 21 Nov 1951.

Unfortunately, during my RMIT & amateur radio days in the late 1960s I rebuilt it with miniature valves for 240V; boy was it wild! It was used here near Corryong up until FM became available. However, I distinctly remember how few components were present underneath in its 32V form. It was an excellent performer.

As a kid, I used to listen to the Argonauts on 2CO (Corowa) our nearest station, but later go to 2GB Sydney for Hop Harrigan and other kids radio. The family would often turn to 3AR or 3LO Melbourne during the day for news, etc from Victoria.

Yes, its audio output was dismal — but distortion was only really notice-

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able when the batteries were down and I remember my father going to lots of effort to suppress the generator. The residual whine was OK and used to follow the beat of the old "Hit & Miss" engine on the generator, as did the dial lights. I must restore it to its original 32V form; the mechanicals and speaker are fine, ply lifting here and there.

Hugh Paton,
via email.

More on the Diason vintage set

Following Rodney Champness's excellent article on the Diason PP 32/6 DC receiver in your February 2002 issue, here are some facts that I have discovered about this firm. It was founded in 1947 by Mr Colin Leason, a former toolmaker, to manufacture radios and sound systems. These activities were first performed in a flat at 5 The Avenue, Balaclava, and later at 10 College Street, Gardenvale (both Melbourne suburbs), where Mr Leason's parents lived.

With his wife Myrtle as a partner and Mr Kevin Peterson, he continued until 1978, at that time concentrating on guitar amplifiers and pickups.

As mentioned in my article in the October 2001 issue of HRSA Radio Waves, the name "Diason" was coined from the first and last syllables of his daughter's name – DIAnne LeaSON. Diason was one of a number of small but not insignificant firms in Australia's postwar radio history.

Bill Smith,
Editor, HRSA Radio Waves.

PC infrared transceiver appreciated

Thanks for the "PC Infrared Transceiver" project featured in the December 2001 issue. I had a need for such a device for the last year and this one fits the bill perfectly.

For over a year I have been writing SIR and FIR drivers for a Linux handheld computer project, along with some core applications that used those drivers. The IR software stack evolved into a data transfer medium that could transfer true Internet Protocol (TCP/IP) through it. If I were to draw the whole stack in picture form it would be higher than "Princess and the Pea" mattress stack.

Your project arrived at a time where I could apply it immediately. Needless to say, it is a real buzz to see it all working. Now I, and a few colleagues, will be able to attach our Linux based handheld computers straight onto the Net via this IR project.

Have you thought of a project that uses low-power short-range radio transceiver modules to do a similar job?

Kevin Bertram,
via email.

Wright Audio Developments AM tuner

Does anyone remember the Wright Audio Developments AM tuner produced around 1974? It was said to outperform the contemporary Quad tuner. The designer now lives in Germany and tells me he lost all his circuits.

Does anyone have a circuit for this? It had a FET bandpass front end, autodyne mixer (I think), manual IF gain and Aegis coils.

David Collier, GPO Box 1755,
Canberra, ACT 2600.

Shutdown for "no keyboard" computer

Here is a suggestion for a small addition to your very useful "No Keyboard" project in the February 2002 issue.

In not having a keyboard on a computer you can sometimes get stuck by not being able to reset or shut down the computer cleanly. By adding a switch which shorts the necessary lines into the keyboard controller to simulate a "Crtl-Alt-Del" key press, one will be able to reboot the computer. To find the lines to short, trace the tracks on the key matrix membrane or PC board.

"Crtl-Alt-Del" is especially useful for Linux since this performs a clean shutdown and reboot of the system. If other keys are needed (F1, for example), these could be added as well. A useful addition would be one of the function keys assigned as a shortcut to cleanly shut down Windows.

Karl Gramp,
Athelstone, SA.

Vintage Radio on the Internet

People interested in Vintage Radio can find plenty of information on the internet. Below are some sample links.

Historical Radio Society of Australia
http://goanna.cs.rmit.edu.au/~dnl/hrsa.html

South East Qld Group of the HRSA
http://seqg.tripod.com/

OZ-Wireless Email Chat Group
http://www.clarion.org.au/wireless/

SEQG Crystal Set Competition 2000
http://www.clarion.org.au/crystalset/

SEQG One Tube Radio Competition 2001
http://seqg.tripod.com/onetube/onetube.html

How to build the mystery Crystal Set, A Great Aussie Crystal Set.
http://www.clarion.org.au/crystalset/mystery.html

Antique Radio Forum
http://antiqueradios.com/cgi-bin/forums/

Rap 'n Tap Crystal Set Chat site.
http://www.midnightscience.com/rapntap/

Ray Creighton,
Everton Hills, Qld.

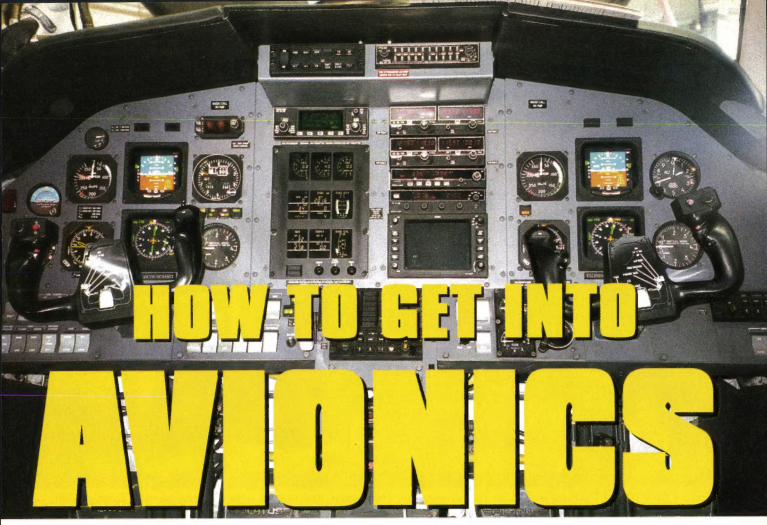
Manual wanted for video monitor

I have a badly behaving monitor belonging to my son. It is a KTX model CAD 415S – does anyone have a circuit diagram and overlay? Or know where I can obtain same.

Kathy Gluyas, 14 William St,
Donvale, Vic 3111.

your on-line provider **www.polykom.com**

POLY kom



HOW TO GET INTO AVIONICS

Ever wondered how to get into Avionics? That's short for Aviation Electronics, a field that can be very challenging and satisfying. This article looks at the work of a typical avionics maintenance engineer and tells you how to proceed if you want a career in this area.

By Daniel Field

Outside my window the engine shut down. It had been running for barely a minute. Curious, I walked onto the tarmac to see what the problem was. The pilot looked at me with the slightly bewildered gaze of someone whose detailed planning has suddenly become worthless.

"The radios don't work," he said, without any emotion. "I can hear, but no-one's responding to my calls." It was the same on both the VHF radios, he told me, and he hadn't tried the HF yet.

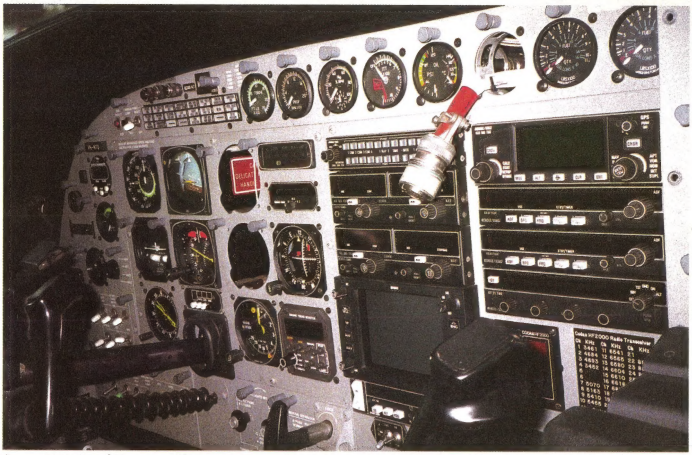
I started checking the standard causes. First, I gave his microphone plug a firm push to make sure it was in properly. "Click". Ah, that might be it. I flicked the power back on and called the control tower. No worries. I tried the second VHF radio. That's good too.

Thanking me profusely, the pilot said it was a good thing, because he had left his lunch box in his car and he would have left without it.

I went back inside, shaking my head. Just another minor occurrence in another very busy day in the life of an Avionics maintenance engineer.

Avionics is an abbreviation of "Aviation Electronics". In the aircraft maintenance industry, an Aircraft Maintenance Engineer (AME) in avionics looks after all the electrical, instrument and radio systems. This may include installing, maintaining, troubleshooting and repairing avionics systems and components.

If you want to get into avionics, you need to know which avenues to try. Do you want to cut your teeth on the big stuff? Are you strictly a hi-tech person? Are you



Cessna 208B Grand Caravan with some instruments out. Top: engine instruments with warning panel in front of pilot. Left: flight & navigation instruments. Centre: ("right" in the picture): radios, radar, autopilot and GPS.

willing to work your way up from the bottom? I hope this article will help answer these questions.

First, let's introduce the three main branches of Aviation:

Military

The Army, Airforce and Navy provide excellent training in Avionics. You can join from 17 to 48 years old. You will be trained initially in Wagga Wagga, NSW, then on-the-job in Oakey, Qld. The training gives you the same qualifications as a civilian course.

After getting your trade you will be posted to a base in a location such as Townsville or Darwin. Your initial enlistment will be for six years.

In the military, your job description will be broader than most civilian aviation jobs. In addition to the standard work on aircraft you will learn to service the ground and test equipment while also being a soldier.

Pros: *Consistently high quality training. A system that gives you room for advancement. Respect from the industry.*

Cons: *Military experience does not automatically transfer to an avionics licence in "civvy street." While your training itself is recognised, it can be very difficult to get any official recognition for your experience.*

The basic reason for this is that military aircraft are not on the civil register. Therefore the Civil Aviation Safety Authority (Australia's aviation regulatory body, generally known as "CASA"), does not have any authority over military aircraft nor the work done on them.

At the same time, CASA is responsible for issuing avionics licences in civil aviation.

I should explain that: without a CASA licence, you can work on civil aircraft but you won't get paid very much. People with military experience outside of CASA's authority find that their experience may not count towards a licence.

Some of the military trained people I know have had frustrating experiences trying to get civilian licences without effectively going back to the end of their apprenticeships.

But it can be done and once you go through the process you should find that the industry generally accepts and respects military experience.

To find out more, try ***www.defence-jobs.gov.au*** or contact the Australian Defence Force Recruiting Centre on 13 19 01.

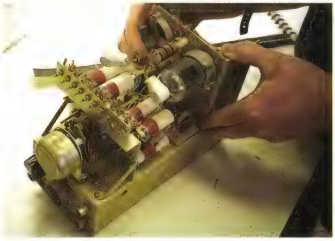
Airlines

This is the "heavy metal" side of aviation. Airlines fly anything from 19 seaters and smaller to the massive Boeing 747-400 series and the planned full length double-decker Airbus A380.

In the airlines you will generally work on advanced, complex avionics systems built for reliability.

You may not realise that there are several significant airlines in Australia; not just Qantas and Virgin Blue. The regional and subsidiary airline market with 30 to 100-seat aircraft is seen as the growth sector within the airline industry worldwide.

If you want to fly between, say, Albury and Canberra, or Brisbane and Rockhampton, you could book a ticket through



A Sunair HF power amp with one valve missing. (Yes, valve!).

Trying to find the cause of intermittent transmit on this twenty-something-year-old Cessna radio.

Qantas but you would actually fly on one of Qantas's subsidiary airlines such as Airlink, Eastern Australia Airlines, Southern Australia Airlines, Sunstate Airlines or Airconnex.

General Aviation

GA is the "everything else" of civil aviation. This includes private owners, charter operators, corporate aircraft and some freighters.

The majority of GA is single-piston- engine aircraft; some new, some old. At the glamour end you have twin-jet aircraft from tiny six-seaters to multi-office-and-boardroom jets designed for productive long-haul flights.

So how do you get into Civilian Avionics? There are two main approaches:

1. An apprenticeship.
2. Tertiary study.

Tertiary study probably sounds like a great idea. It is, as long as you keep in mind that people with degrees generally don't get to work on aircraft.

For example, you could do a Bachelor of Engineering in Aerospace Avionics at Queensland University of Technology. This course "...prepares students for careers in the expanding field of aircraft and spacecraft instrumentation and in associated ground equipment."

You would find that the course is quite deep mathematically and also covers management considerations. By the end of the course you will know more about Avionics than the best tradesman.

But with only three months of work experience you probably won't be able to remove a gyroscopic instrument from a Cessna single without breaking something.

Compare that to a certificate IV in Aeroskills (Avionics) at Kangan Batman TAFE, also known as the trade course.

It prepares students for "...employment with international and domestic airlines, in aircraft production and refurbishment, and corporate and general aviation."

This course is light on theory compared to the degree (though you still learn a lot). Students will generally be working in the industry for about eight or nine months per year and will be fully ready to work as Aircraft Maintenance Engineers the day they finish.

If you want to get into design then yes, get a Bachelor of Engineering, or perhaps an Advanced Diploma in Avionics. But if you want to work on aircraft avionics systems (and I mean **actually** work on them), do yourself a favor and do not put a degree at the top of your list of options.

That leaves us with Apprenticeships. Apprenticeships have two outstanding advantages:

1. You get paid while you learn.
2. You work as you learn, so you get to touch, break, smell, see, repair and play with the things you are learning about. When you come out of an apprenticeship you are fully ready to do the work.

Perhaps I should introduce myself. I am a fourth year apprentice in General Aviation. I work on mail planes, charter planes, trainers, small freighters, some small regional airliners and the Royal Flying Doctor Service aircraft. I install, maintain and repair all sorts of electrical, instrument and radio systems and components.

When you look at apprenticeships, it's worth thinking about the differences between the airlines and General Aviation.

In the airlines you will work on more advanced avionics in larger aircraft. The large airlines train you to work in a specific area: Line Maintenance, Heavy Maintenance or Component Overhaul.

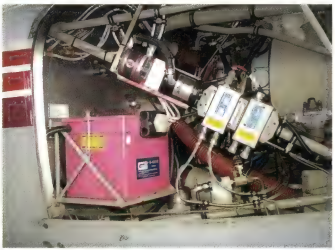
Line Maintenance means "turnaround" checks and trying to quickly solve problems that have recently come up. This usually involves "box swapping" until you find the box that is faulty and then send it away for repair.

Heavy maintenance means checking and repairing avionics systems while the aircraft is in the hangar for several days or weeks for a major routine inspection. This is also a box swapping job, as well as checking and repairing the several kilometres of wiring running all over the aircraft.

Component Overhaul is the benchwork side of aviation: testing and repairing the "boxes" – generators, instruments, etc, that have been removed by the line or heavy maintenance techs. The bench techs may overhaul electric motors, repair and calibrate instruments or test and repair electronics to board or component level.

The great thing about General Aviation is that you can do it **all**!

I spend about 50% of my time doing "line maintenance"



Cessna Grand Caravan battery, standby instrument vacuum system and high energy ignition units.

Our 2nd year apprentice getting access to a Cessna P210 instrument.

(including 100 hourly checks), about 30% doing "heavy maintenance" such as modifying systems, installing new equipment and chasing faults that have not been solved by box swapping and about 20% of my time doing "component overhaul" in our radio workshop.

Practically every GA outfit does line and heavy and a large percentage also do component overhaul.

In the airlines you may work on three or four different aircraft types, or possibly specialise in only one or two, for example, Boeing 737-300 and 737-400.

In GA, you will work on more types than you can remember. A sample of my own list is: Cessna 172, 182, 206, 207, 210, 402, 404, Beech Bonanza, Baron, Piper Seneca, Cherokee, Lance, Navajo, Chieftain, Shrike Aero Commander, Parten-avia (all single and twin piston engine aircraft, up to ten seats), plus Cessna 208B Grand Caravan, Pilatus PC12, Beech Kingair 200, Fairchild Metro 23, Embraer Brasilia (all single and twin turboprop aircraft from 10 to 30 seats), plus Robinson R22, R44, Bell 206 Jetranger (helicopters). These are just the ones I had worked on at least a few times within my first two years of avionics.

Any work that is done on an aircraft or its components must be certified. To certify work you must have an Aircraft Maintenance Engineer's Licence. These licences are issued by CASA.

How to get a licence is another story altogether. For now, you should know that only a select few in the airlines ever get a CASA licence. In General Aviation almost the reverse is true, with nearly everyone encouraged to get at least one licence.

Having or not having a CASA licence is one of the biggest single factors effecting your income in civil aircraft maintenance.

In the airlines, unlicenced workers are paid more than in GA. The basic reasons are that the aircraft are in a different legal classification because they carry fare-paying passengers on regular routes and they are over 5,700kg which puts them in a different category for CASA licences.

An airline apprentice generally has a higher base wage than a GA apprentice. Table 1 shows the wages for both Qantas and GA apprentices.

When you finish your apprenticeship with Qantas your wage would be about $610.00 per week if you don't work on aircraft and about $640.00 per week if you do.

It is very important to realise that most of Qantas's finishing apprentices will not work on aircraft: they do component overhaul in workshops.

If you do component overhaul it is unlikely that you will ever get a CASA licence. Qantas only fills licenced positions as they become vacant and they choose people based on performance and qualifications.

Qantas also offers a Graduate Trainee Program so you can follow your apprenticeship with an engineering degree.

For those who get neither a licence nor a degree, your prospects are to progress through the Qantas ranks to Maintenance Supervisor or a job in management. Alternatively you could move "sideways" into another related industry such as industrial motor overhaul, consumer electronics, etc.

On the other hand, when you finish your apprenticeship in General Aviation your base wage would be about $480.00 per week (minimum).

The major and very important difference is that you will almost certainly be very close to getting your first CASA licence. All it requires is some aptitude and effort.

Once you have your first licence your wage will jump to around $530.00, depending on which licence it is. Within a year of your apprenticeship ending, if you put in the effort, you could have Electrical, Instrument and Radio licences in multiple categories. This would set your minimum wage around $750.00 per week. Depending on which licences you have, you could be highly sought after.

If all you want is the money then you can get certain hard-to-find licences (certain helicopters, or the latest bizjets, for example.) Typical wages in this niche of GA are around $50,000 to $65,000 per year in Australia and possibly that much in US dollars if you are willing to work in God-

Table 1: Weekly Rates of Pay for Avionics Apprentices

	Qantas	General Aviation
1st year	$269.00	$171.40 (minimum)
2nd year	$352.50	$224.50 (minimum)
3rd year	$480.40	$306.10 (minimum)
4th year	$563.70	$359.10 (minimum)

Replacing a lighting dimmer pot in a Super Kingair used for charter work.

forsaken countries of the world at all hours.

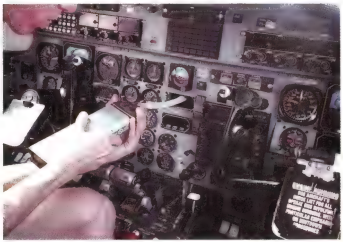
Airlines generally advertise their apprenticeships in major newspapers. However, if you really want to get an airline apprenticeship then you should contact every airline you can think of, get their application forms, and apply.

Remember to contact every regional and subsidiary airline that you can, not just Qantas.

During my apprenticeship I studied with two Ansett avionics apprentices. The word on the street was that about 2,000 people applied for Ansett apprenticeships that year. About 60 were taken. Of those 60, only two were put on as avionics apprentices. That's two out of two thousand applicants.

It is only fair that I tell you at the time Ansett ceased operations, both those apprentices felt that they would most likely end up in component overhaul, even though they both wanted to do line maintenance and they were entirely capable of it.

My best advice for getting into the airlines is to keep



Changing the altitude alert selector in a Fairchild Metro. Notice it mounts from the front: much easier than rear-mounted, as used in smaller aircraft. Notice the sections of the panel. Across the top: radios, audio and warnings. In front of pilot: flight instruments (electro-mechanical). Then: two columns of engine instruments: Left & Right. Centre: radar, GPS, fire warning/extinguish, standby and auxiliary instruments.

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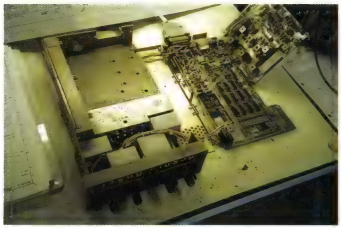

A combination of analog and digital circuits is found in this VHF communications transceiver/navigation receiver, typical of Cessna aircraft from the '70s and early '80s.

Crimping a connector for de-ice wiring: windscreen replacement on a Pilatus PC-12, used for regional mail runs, charter and carriage of goods and people for the Aboriginal corporate owners.

trying, be proactive, and make sure you always show them that you really want to work for them.

By proactive I mean you should try to make your own opportunities: don't just wait for a newspaper advert to appear. Apply for apprenticeships everywhere, even if you are told there is nothing available. Be prepared for a lot of "No" answers and also be prepared to keep trying for every opening you see.

There is no set procedure for getting into General Aviation. Most of the avionics workshops are genuine small businesses with around two to ten employees. The business owners and workshop managers are flesh-and-blood people with concerns about the fickle nature of the aviation industry. Some of them may have been laid off by various airlines up to three or four times over their careers.

In this setting you will understand that some GA avionics businesses may consider putting on an apprentice for several months or even years without ever taking the step of advertising for one.

If you can find one of these businesses and show that you are both able and interested, chances are you will get a week's work experience with a view to becoming an apprentice.

I personally decided to seriously try for an apprenticeship in October 1998. I wrote a letter, included written references from my employer at the time (a mobile phone shop) and my previous employer (a Retravision store).

I included all my school results, science and maths competition results and details of an unrelated qualification from my retail work. I emphasised my strong maths and science background and the positive comments of my previous employers. I sent all of this to an Avionics workshop in Mackay that had advertised for an Avionics apprentice.

I didn't get the apprenticeship.

Still enthusiastic, I rang another organisation that I knew had avionics engineers. They told me to send my information but there was not really anything available. I sent them my package.

A week later, they sent the same information to a related company in Alice Springs. After some discussions they decided to take me on, provided I worked in the hangar for a year before starting on Avionics. Now I am in my fourth year and I should be able to get several CASA licences as soon as my apprenticeship finishes. So my advice for getting into General Aviation is really the same as for the airlines, only there are a lot more places to try.

Keep trying, be proactive, show your enthusiasm. Be prepared to do a week of work experience as part of the process. My only word of caution is that you must make sure you know what you are being offered before you accept anything.

With such diversity in GA there is no guarantee that your prospective employer will help you get CASA licences, or that you will work on any more than one or two aircraft types. It is in your interests to know what sort of work you will do and how far the employer will encourage you to go, right from the start.

My last bit of advice is for older people who want to work with avionics but cannot live on apprentice wages. Remember that all the GA wages I have quoted are *minimum* wages, set out in the Aircraft Engineers (General Aviation) award.

As a mature-aged person your job is to convince a potential employer that it's worth taking you on instead of a 17-year-old. Part of taking you on is to pay reasonable adult wages. The main thing is to be (surprise, surprise) proactive and positive. List all the reasons why you are better, convince yourself, then set out contacting every place you can.

It's also worth thinking "outside the box". At the moment it is still possible to gain your CASA licences without doing an apprenticeship.

You need to pass all your exams and fulfil the experience requirements but it's possible to do your experience as a trades assistant or (really outside the box now) an accountant or taxi driver who works on aircraft 20 hours a week, etc.

Please take me seriously when I say that this door is almost closed now. New legislation currently being introduced will effectively make it impossible to sit the licencing exams without attending an approved course. So if you want to get into Avionics without doing an apprenticeship, DO IT NOW!

I hope that's enough to get you started. Anyone who likes aircraft and enjoys electronics would agree that Avionics is the greatest industry in the world.

Keep trying and maybe we'll meet at a trade fair or in the tail of an aircraft one day. **SC**

To understand why $6,843 is a fair price to pay for VAF kit speakers, read 580 words from a violinist who can't use a screwdriver.

The following is an excerpt from a review which appeared in Audio Video Lifestyle Consumer Guide '99 by Sian O'Neale.

"Phillip Vafiadis is the creative talent behind the brand and his aim with VAF Research is to market kit loudspeakers of uncompromising quality at the serious end of the hi-fi market.

The VAF range is priced from $312 a pair right up to $8,863 a pair*, so we're talking serious money here for serious equipment.

We at AVL magazine have been particularly impressed with DC-X series.

These kit loudspeakers are not the standard packages from consumer electronics stores. In fact, you won't find these products in any store. The company prefers to cut out the middle-men and save buyers money, so every product is available factory-direct.

The VAF Signature series includes the Signature 1-66 and 1091 loudspeakers. Taking delivery of the 120kg 1-66 floorstanding speakers is something of an experience; I have never seen such an imposing crate for a pair of loudspeakers before. Fortunately my brother Crispin is capable with the screwdriver and we took out the massive 1-66s. You will need quite a bit of muscle and help to unpack these speakers and get them where you want them. The engineering and attention to finish that has gone into these fully assembled VAF Research 1-66s is simply awesome.

These elegant but powerful looking loudspeakers come with removable velcro attached grilles in a 3-way design; a 210mm hard paper bass driver with solid copper phase plugs and a 25mm double chamber sonotex dome tweeter with a pure silver wire voice coil. Turn the speakers around and you have very high quality gold plated binding posts which allow for bi-wiring and tri-wiring.

The same meticulous attention to detail and build quality also goes into the smaller 1-91 models, three of which are presented as left and right rear surrounds and a centre channel speaker for home theatre use (which has a custom-designed grille for a centre channel speaker). But the 1-91 loudspeakers have been designed to also perform as high quality studio monitors with the same superb sound as the 1-66s.

The speakers were designed to be used close to a rear wall and that's how customers use them, ideally 15cm-40cm from the nearest wall. But I think the speakers sound better when they can breathe more easily. Find the right position for the room and you will be richly rewarded.

The big VAFs deliver a stunning soundstage which is wonderfully insightful and involving. Large scale orchestral works have a level of depth and accuracy that only the best loudspeakers can manage.

As a violinist, I am often left unimpressed with the sound of the violin through so many loudspeakers (even high-end models), but here the presentation is accurate and engrossing. Instrument separation between different members of the orchestra is faultless.

This is particularly obvious when listening to Hans Zimmer's evocative soundtrack for The Thin Red Line in which quiet, gentle music provides so much power and atmosphere.

As a system for home theatre, together with the smaller satellite 1-91s, VAF has assembled an incredible system. Bass extension from the 1-66s is awesome; deep and thrilling, which is ideal for action blockbusters such as Speed, Twister or Titanic (you don't just watch the ship sink - you feel it through the floorboards). The centre channel speaker locks dialogue firmly into place and steers the sound with maximum impact; dialogue in Speed comes across as frantic as the driving. Full marks."

* Figures amended to reflect current pricing.

For the entire transcript of this review or information on our 14 models contact VAF Research and ask for your copy of "What the Critics Say". Free call 1800 818 882. Email vaf@vaf.com.au or surf www.vaf.com.au

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ATTENTION

Project Designers and Hobbyists can now make their own professional quality, one-off panels, labels and signs

When a SILICON CHIP project is released as a kit by one of the major suppliers, almost invariably it includes a front panel to make the project look professional. But what happens when there is no kit – or when you want a panel for one of your own projects? And what do R&D labs do?

It has long been one of the stumbling blocks in building your own projects: how to make them look as good as they work! Hobbyists are not alone in this – professional designers – even here at SILICON CHIP – have had similar problems in making a prototype look "professional".

There have been various commercial systems available over the years: perhaps the best known was the self-adhesive aluminium "Scotchcal" (and later "Dynamark") labels from 3M. However, these were withdrawn from sale some time ago.

Back in February 1999 we told you how we did it for many of our projects: by laminating a laser print or inkjet print with self-adhesive plastic and glueing that to the case.

While that method works and looks pretty good, it certainly isn't as permanent or hard-wearing as a proper silk-screened or engraved panel. But as far as the projects we publish are concerned, that isn't a major problem. We just need them to look good long enough to photograph them – it's up to the kit suppliers to include "proper" panels.

But there are many times when we build a project which we DO want to keep for a long time and use, just as our readers would be doing. What we usually do in that case is make the temporary (printed) panel and then when the kits are released, beg, borrow or buy one from the suppliers to replace ours.

Then (as often happens) something caught our eyes: a press release from Perth-based Computronics Corporation (*www.computronics.com.au*) promoting their new "Quick-Mark" system of producing self-adhesive labels, signs and front panels. Front panels? What was that again?

By Ross Tester

Computronics is not new to us. Readers may recall a little over a year ago (March 2001 issue, to be precise) we described an easy way to produce your own PC boards using Computronics' "Kinsten" photo-resist board blanks and nothing more than a photocopied or laser printed PC board pattern on ordinary bond paper.

We've made countless PC boards over the past year or so using this method and have achieved exceptional results.

It's relatively simple to achieve very high resolution (for example, two or three point type in board markings, too small to read with the naked eye but which can be read with a magnifying glass).

If the Quick-Mark system was anywhere near as good as the Kinsten system, the panel problem could be solved.

So we asked Computronics' Kevin Dare for a few samples and some in-

structions – and set about proving it one way or the other. You be the judge!

The Quick-Mark system

There are two (or three) parts to the Quick-Mark system. First is a range of exposure films which set the letter colouring of the panel. This film is available in a range of colours: black, dark blue, red, green, light blue, brown, white and grey/silver.

Second is a range of base sheets, which set the background colour of the panel – most are a plastic but there are also aluminium base sheets. Again, these come in a range of colours: the plastic are white, yellow, silver, transparent, red, gold, orange, beige and blue.

There are plain and gold aluminium and also premium white and aluminium sheets. These have a thick, premium 3M adhesive, particularly good for sticking panels to rough, non-smooth surfaces and low energy materials such as polypropylene and polyethylene. They are also significantly more expensive.

Third (and not usually needed) are the over-laminating films, available in transparent, matt and Lexan. For reasons which we will go into shortly, if the emulsion side of the exposure film is towards the inside, the film itself obviates the need for an over-laminating film.

You can mix'n'match the colours of the exposure films and base sheets to your heart's content. If you want a dark blue label on a yellow background, simply choose the appropriate (dark blue) exposure film and (yellow) base sheets.

Like PC boards, the Quick-Mark system depends on exposing the presensitized exposure film to UV light through a suitable image. But that's where the similarity ends.

Where the PC board is then developed, dried and etched, the Quick-Mark system can take a couple of different routes. That's because the exposure film produces, at the same time, positive and a negative images of the original artwork.

Which you use depends on whether your artwork is a positive (ie, black lettering/images on a white or clear background) or a negative (clear/white images on a black background).

Once exposed, the two parts are separated using a special "Peeling Board" and the required piece of film

Here's a selection of the colours available in Quick-Mark. The "Roman Road" sign also gives a good idea of the resolution possible with a good (high contrast) original artwork with dense blacks and clear/translucent whites.

is then secured to the base sheet (which has self-adhesive on both sides). We'll look at the actual mechanics of this shortly.

The top piece of film is higher gloss than the bottom – this may also influence which one you use.

If necessary, a piece of over-laminating film is also secured at this time. Finally, the panel/label is cut to size and secured to the project.

Emulsion-to-emulsion

We've already looked at the difference between positives and negatives but before we get into the nitty-gritty of producing a label or two, a word on a long (hyphenated) word: "emulsion-to-emulsion", and also on "wrong-reading" and "right-reading".

What emulsion-to-emulsion simply means is that the emulsion, or toner image on the film (or paper) being used for exposure is in direct contact with the UV-sensitive emulsion on the imaging film.

Basically, what you are doing is avoiding any UV light scatter or "bending" which can occur when you pass the light through a sheet of film or paper **after** the image. Especially in paper but also in the types of film used for laser printing, the light path can be interrupted by fibres and even defects in the material.

If the light passes through the material first, then the image, what you get is a more faithful reproduction of the image.

You'll also hear the expressions "emulsion up", "emulsion down", "right-reading" and "wrong reading", probably used in conjunction with each other.

"Emulsion down" for all intents and purposes means the same as "emulsion to emulsion". "Emulsion up" means the emulsion is on the side of the film closest to you (ie, away from the material being exposed).

"Right reading" means that as you look at the exposing film, you can read the words normally. "Wrong reading" means that the words are back-to-front or mirror image. (Hold a sheet of normal laser-printed paper up to the light, unprinted side towards you. Notice how everything is back-to-front? That's wrong reading!)

Negative acting

A short time ago we said that Quick-Mark produced both a positive and a negative at the same time. And so it does. But Quick-Mark should be re-

SIX EASY STEPS TO A PRO-QUALITY

1: The better quality your artwork, the better your final result. Blacks should be as dense as possible

2: Expose the imaging film to UV light through your artwork film. Test strips can be used to determine time.

3: Use the peeling board to separate the positive and negative exposures. Either/both can be used, as required.

garded as a negative-acting process in order to get the final emulsion of the label or panel on the right side, thus avoiding the use of an over-laminating film.

Of course, if you WANT to use an over-laminating film anyway (perhaps to create a matt finish or to use the super-strong Lexan film), it doesn't matter which way around you go.

Normally, though, you would use a right-reading, emulsion-down negative artwork to produce a positive label.

Producing your artwork

The first step in producing a professional-quality label or panel (using any system) involves its design. With today's computer software, this task has been made relatively simple but there are some traps for young players!

(1) Avoid too many fonts. Most panels/labels look best with at most two fonts – and often one of those is a variation of the other (eg, bold and normal weight).

(2) Also avoid fancy fonts. For some reason, many people go straight to "Old English" styles of typefaces, which have to be amongst the most difficult to read faces ever invented. You might think Helvetica is boring – but you can read it instantly. And that's what a good panel is all about!

(3) Faces with serifs (the little strokes at the top and bottom of letters), swashes (flowing artistic flourishes), etc, are best avoided on panels.

(4) Large logos might give the manufacturer a warm and fuzzy feeling but do nothing for the end user. Keep logo sizes down!

(5) Linework should be neither too bold nor too fine. Bold lines might detract from an otherwise great design; fine lines can be difficult to reproduce.

(6) If you are making a one-off panel for your own use, consider what is going to be near the device. Reversed panels (ie, white lettering on a black background) have tended to be out of fashion in recent years (some notable manufacturers excepted!). But if most of your hifi gear, for example, is white on black, a new black-on-white device (or a different colour) could stick out like a sore thumb!

(7) When you've come up with your design, print it out on a laser or inkjet printer and ask other people what they think of it. Don't be hurt by criticism!

(8) Above all, keep type straight and on the same horizontal and vertical lines where appropriate. Nothing looks worse than higgledy-piggledy type!

Printing your artwork

The instructions for Quick-Mark refer to transparent or translucent film for the artwork – they don't mention using bond paper. But then again, neither did the Kinsten PC board instructions – and we're achieving great results with that and bond paper.

They do mention a proprietary film called "LaserStar", a translucent film made for the production of high resolution, dense PCB artworks directly from any Laser printer. It will also accept copier toner enabling usable artwork to be produced from pre-printed originals.

We understand Computronics will be stocking this material soon but at the time of writing, it was not available in Australia.

So for the moment, we're stuck with using ordinary laser/photocopy paper.

By the way, don't even think about using overhead projector transparency film. Its blacks are usually anything but! (Hold a printed sheet up to the light and you'll see what we mean).

As we found with Kinsten PC boards, a good quality laser print or photocopy works fine – as long as you get the UV exposure right. But more on this shortly.

What you are looking for in your print is very dense blacks (you should not see any variation in darkness when you hold the page up to the light) and no tone scatter or scumming in the whites.

Many laser printers are fully automatic, not offering an exposure (or "darkness") control. But if yours has, experiment until you get the best possible blacks without affecting the whites.

Photocopiers almost always have an exposure control. The same rule applies if you are copying a PC board pattern from SILICON CHIP (or an overseas magazine, for that matter).

Here's a tip for photocopying: al-

ABEL, SIGN OR PANEL

4: Stick the film to the self-adhesive base sheet using a wetting agent for slip. Squeegee out air bubbles.

5: Add extra lamination if required; allow to dry then guillotine (or cut) the sign/panel/label to size.

6: And it's finished. Remove the cover from the adhesive on the back and secure in its final position.

ways place a piece of black paper against the other side of the leaf you are photocopying. This will tend to mask the print and illustrations on that page, allowing you to adjust the exposure for best possible results.

Don't know where to get a sheet of black paper in a hurry? Raise the lid of your photocopier and press the print button . . .

Exposure

There are a couple of minor wrinkles here. First of all, the exposure time needs to be determined and that can be affected by the age of the material and the type of paper you are printing on.

The second thing to watch is something we have already talked about: type of original (negative or positive) and emulsion side/reading. These factors determine how the film will be exposed relative to your original.

Ideally, if a positive label is required, a right-reading, emulsion-side down negative artwork should be used.

Quick-Mark should be considered as a negative-working system. However, as we said before, Quick-Mark produces simultaneous positive and negative film. The difficulty about producing a positive from a positive is that the emulsion in the final label ends up on the outside, requiring extra lamination.

If you want to make a positive label from a positive artwork, it should be wrong-reading, emulsion down.

A piece of imaging film of the required colour (ie, the lettering and markings on the panel) is cut slightly larger than the finished panel size. Remember that this film is UV sensitive so should not be exposed to room light (especially fluorescent) light for any longer than is necessary. Put it back in the lightproof container as soon as possible.

It must never be exposed to sunlight (direct or reflected).

The film is placed in a UV exposure box (or frame) with the shiny (emulsion) side towards the UV source with the artwork between the film and the source.

Masking

The film is masked to aid later peeling. Once you have laid the artwork on top of the imaging film you should apply two masking strips along two joining sides. For masking strips you can use offcuts of the black imaging film. This means you have two joining sides and one corner that have not been exposed to UV light. The top layer is peeled from the unexposed corner. Having this unexposed corner makes the peeling process much easier. If you do not mask as above,

lifting an initial corner and the peeling itself is much more difficult.

By definition, if you are using a big negative artwork with plenty of black opaque areas along the edges then masking may not be necessary as the negative is doing the masking for you. But if using a positive, masking will be required.

Exposure

The film is then exposed to UV for the required time. We cut several small test strips and exposed these for various periods to determine our optimum exposure time – somewhere between 15 and 25 minutes or so for our setup. We were using the Kinsten UV exposure unit; if you are using another UV source, your exposure times may be different. Just experiment until you get an acceptable result.

Exposure time is a compromise between ensuring sufficient UV light gets through the white paper to the sensitized film underneath but not enough to start "punching through" the black (toner) areas of the artwork.

Exposure time using high contrast film is dramatically less: seconds, rather than minutes.

Peeling the image

An adhesive-coated "peeling board" is used to help separate the film once exposed. Lay the film onto the peeling board with its glossy side up (the side which was exposed to UV) and smooth out the film.

Peeling is a bit tricky. First you need to separate the two layers of film with your finger nail at one corner, then grasp that raised section with your thumb and forefinger and peel it (away from the corner) without raising the film up.

In other words, peel it back on itself – as you would do in trying to remove an adhesive bandage from your skin: do it quickly in one movement and it doesn't hurt as much!

It is also vital that this be done in one, smooth, continuous motion – if you stop or hesitate, the panel could be ruined by lines or imperfections.

When the two pieces of film are separated, you'll find the top piece is a reversed image of the original artwork with the coloured emulsion side underneath (in other words, if you used a negative, you'll now have a positive, right reading, emulsion side down).

The other piece of film, still stuck to the peeling board, will have an exact duplicate of the original artwork with the coloured emulsion on top.

You can use either piece of film as your panel, depending on which way around you want it to look.

Now you should start to understand why we made such a fuss of positives, negatives, emulsion sides, etc before; if you only had positive artwork and wanted a positive panel, a positive artwork, right reading emulsion side up is produced, (the same as an ordinary letter is produced).

This is then turned over (wrong reading emulsion down) placed on a piece of imaging film and an exposure made. The image is then peeled and the bottom piece of film is used. On the peeling board this is wrong reading emulsion side up but when removed and turned over and stuck to a base sheet produces a right reading, protected emulsion panel.

Laminating

Now comes the easiest part: laminating the piece of film to the base sheet.

The base sheet is not UV-sensitive so you don't need to take such precautions with it. Cut a piece of base sheet just larger than your label and place both it and the label film, in a plastic tray (or perhaps on a large newspaper).

Peel away the protective coating from the coloured (top) side of the base sheet and spray both it, and the label film, with a fine mist water spray into which you have added a couple of drops of concentrated household detergent.

Don't use enzyme-based detergent: it will damage the adhesive.

The "slippery" water allows you to place the film on the base sheet without the "sudden death" of most contact adhesives. You should be able to slide the film around a little should that be necessary.

Once you are happy with the position, "squeegee" the water out from under the label. Computronics have an applicator pad for the purpose which you might consider if you are doing regular labels – otherwise, squeegee it using a soft cloth.

Some small milky blotches may appear between the layers of the label: don't worry, these are quite normal and usually disappear after a day or so as the water dries out. Squeegeeing as much liquid out as possible tends to minimise this effect.

Extra lamination

If your image is on the upper side of the film and/or if you want to change the shiny label to matt or cover it with the tougher Lexan, you do this by using over-laminating film.

Otherwise, you don't need to do this because the emulsion will be "sandwiched" between the imaging film and the base sheet.

Finally . . .

Now's the time to cut your panel to size (preferably with a guillotine, but scissors can be used) and fix it to the object required. The same type of acrylic adhesive is on both sides of the base sheet so again, a fine spray of slippery water (water/detergent mix as above) can give you a bit of movement.

Acrylic adhesive normally takes some hours to finally cure but when it does, the panel will be very tightly stuck on, by gum!

Cost

The Quick-Mark components are not cheap. However, when alternative methods may be non-existent or much more expensive, it all becomes relative.

The imaging film costs around $50 per sheet or about $35 per sheet in a pack of five. Each sheet measures 305 x 508mm, so you should get many projects out of a single sheet.

Likewise, the base sheets are 305 x 508mm. The normal sheets cost about $30 each or about $21 each in a 5-pack. The "premium" sheets are about $44 each or $31 in a 5-pack.

Large peeling boards are about $50, small about $38. They also have application fluid to help enable accurate positioning of the film on the base sheet.

Personally, I would take their tip and substitute ordinary water with a couple of drops of concentrated washing-up liquid in a sprayer bottle (cost about two dollars compared to about $40!).

Where do you get it?

For more information, refer to the Computronics website, www.computronics.com.au, or call (08) 9470 1177, fax (08) 9470 2844. **SC**

Better cooling systems for car engines

Up 'til now, engine cooling systems have all been based on a mechanical thermostatic valve, a belt-driven water pump and cooling fan which is now usually electric. Now that is all about to change.

Electronics has brought about great changes in motor vehicles, especially in regard to fuel consumption, emissions, safety and comfort.

Almost all functions today are controlled and monitored electronically. The cooling system in the engine has been the exception.

The German company Bosch is now developing electronically controlled thermal management for the engine. This is expected to reduce fuel consumption by up to five percent and also raise the heating comfort within the vehicle by controlling the temperature in the passenger area faster and more evenly.

Electronic engine thermal management aims to optimise the heat balance in the engine and transmission. Depending on the operating conditions and load requirements of the engine, the system controls the coolant temperature and coolant flow in a highly dynamic way.

As a result, the engine reaches its operating temperature faster after a cold start and this helps reduce the emission of unwanted pollutants.

At engine idle and in the part throttle range, electronic thermal management permits a higher engine temperature. The resulting lower oil viscosity reduces engine losses and leads to further fuel savings compared to traditional engines.

In contrast, at high engine load the coolant temperature drops faster and even with sudden full power (open throttle), temperature spikes do not occur. This is easier on the engine and may contribute to a longer lubricant life.

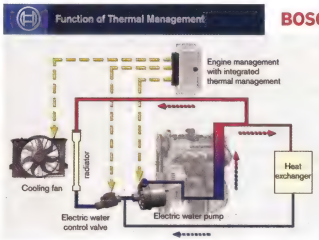
Thermal management therefore could also enable longer service intervals.

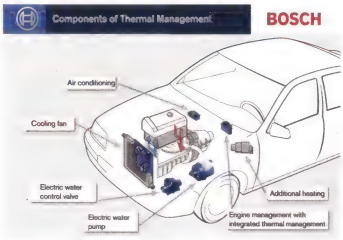
Finally, the heating of cars will benefit from electronic thermal management. Constant heating, independent of engine load, raises passenger comfort and saves the step of subsequent frequent temperature control, which is usual for conventional vehicle heating systems.

The key components of a thermal management system have continuous electronic control and include:

- A cooling fan driven by an electric motor
- One or several electrically-actuated proportionate water valves as replacement for the traditional thermostat valve
- A primary water pump, driven by a 14V or 42V electrical supply.

Variable speed cooling fans are already in production. Bosch is developing the other key components with the first applications in series-produced passenger vehicles scheduled for 2004. **SC**





DICK SMITH ELECTRONICS

Where do you go for the latest new releases?

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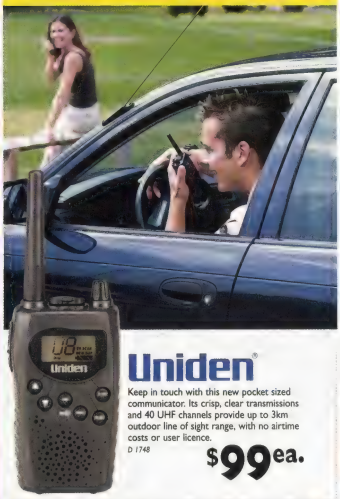

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+

BONUS

Combination Drill Set valued at $12.50!

A handy selection of drill bits, screwdriver bits and rawl plugs. Includes: 2, 3, 4, 5, 6, 8 and 10mm HSS drills, 4, 5, 6 and 8mm masonry drills and 4, 5, 6, 8 and10mm drills. Selection of Flathead, Phillips and Pozidrive bits (6 pieces total). Magnetic bit holder. Selection of 4 sizes of plastic rawl plugs (over 250 pieces).

T 9909

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Sensor type: Colour CMOS image sensor.
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Image format: Composite.
Pixels number: 628 x 582 (365k).
Sensitivity: 5 Lux @ f1.4.
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Operates in low light conditions (approx. 5 Lux).
Power requirement: 200mA.

L 5843

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K 3018

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SILICON CHIP Dec '00

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LOW PRICE!

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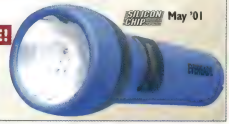


SILICON CHIP May '01

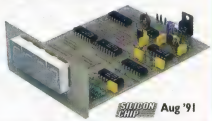
Digital Tachometer Kit

Four-digit display works with ignition systems on 4, 6 and 8 cylinder motors. Supplied with components, PCBs and LED displays. Power source required: 12V battery (not included).

K 3241

SAVE $8

$29.50



SILICON CHIP Aug '91

4-Channel Mixer Pre-Amplifier

Features separate bass, treble, mid-range, input and output level control. Frequency response: 18Hz-35KHz (+/- 3dB). Power source required: +/- 15V DC. Supplied with PCB, all components, and hardware. Case optional (use *H 2481*).

K 5400

$46.93 **SAVE $12**

SILICON CHIP Jan '92

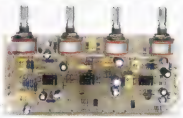
DISCOVERY Stereo Pre-Amplifier Kit

Upgrade your bare power amplifiers into a complete audio system with this quality pre-amplifier. Features volume, bass, treble and balance controls. Supplied with PCB, pots and all necessary components. Case optional (use *H 2852*).

K 2811

SAVE $10

$29.85

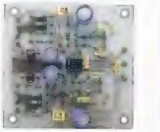


Universal Pre-Amplifier

This low noise stereo pre-amplifier is easy to build and ideal for use with magnetic cartridges, cassette decks or microphone inputs. Supplied with all components and PCB. Case optional (use *H 2851*).

K 5402

$16.90



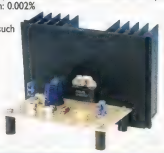
SILICON CHIP Apr '94

50W Amplifier Kit

Extremely low distortion. Output power: 50W continuous into 8Ω. IHF power output: 60W @ 1KHz. Distortion: 0.002% @ 40W 1KHz. Supplied with all components, PCB and hardware such as fuse and heatsink. Case optional (use *H 2481*).

K 5606

$39.50



SILICON CHIP Mar '94

Vader Voice

Here's one for Dr. Who and Star Wars fans! Disguise your voice to sound like Darth Vader or a Dalek. Supplied with all components, PCB, hardware, case, speakers and front panel label.

K 3511

$29.93 **SAVE $6**

SILICON CHIP Sep '95

direct link Direct Link is equipped with the service centre to supply you with a hassle-free delivery direct to your door. **PHONE 1300 366 644** to place your order.

Availability: Our kits consist of many different parts from numerous suppliers. Whilst we have consulted closely with them and are satisfied as to their ability to supply, sometimes problems can arise in obtaining all of the parts. This means there is a slight chance that availability may be delayed. Rainchecks are available, however if you'd like to check beforehand, please don't hesitate to contact your local store. Offers expire 30/4/2002. ***Limited stock** All stocks marked clearance, limited or with an '*' may not be available in all stores or via Direct Link. Rainchecks do not apply.

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and you get, FREE, a 14.4V Cordless Drill valued at $89.78 with fully variable electronically controlled speed from 0 to 650RPM. Features forward/reverse switching with a lock off position, a powerful Johnson motor, and 6 torque settings (up to a massive 12Nm).

Q 9941

Helping Hands With Magnifier

It's bargain-priced and makes working on PCBs much easier! Includes a heavy cast-iron base for added stability, a magnifying glass, plus alligator clips to hold the PCB still while you're working on it.

T 5715

$9.90

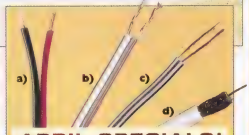
1mW Keychain Laser Pointer

Incredibly small, this 1mW laser pointer is contained in a tough metal housing just 9mm in diameter and approximately 50mm long. Includes keychain with springclip for convenient storage. Powered by three watch-style batteries (included).

T 2903

$19.93

SAVE $10



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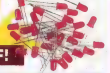

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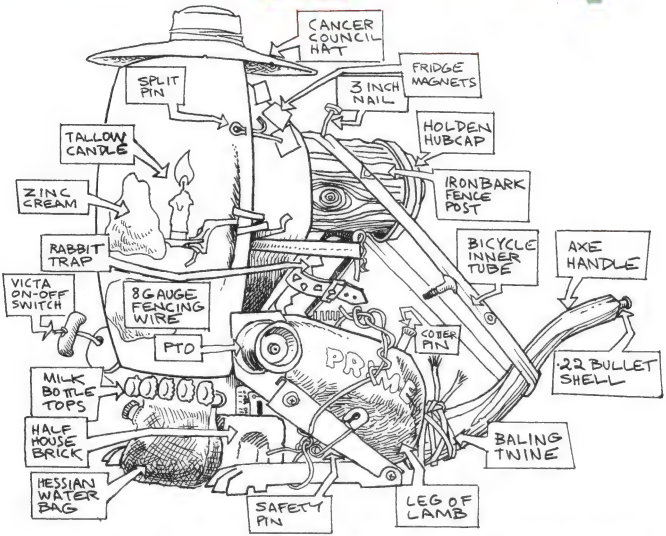

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Volvo's ISG cuts fuel consumption by 20%

Reducing fuel consumption is one of the top-priority environmental goals at Volvo Cars and one of the most promising projects in this sphere is the Integrated Starter Generator (ISG) which was demonstrated at the 2001 Frankfurt Motor Show.

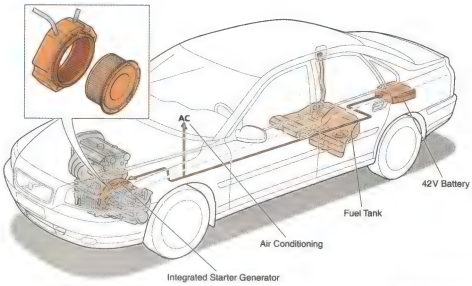
Hans Gustavsson, who heads the Research, Development and Purchasing unit at Volvo Cars states: "In urban driving with its many stops and starts, ISG can cut fuel consumption by as much as 20% and also reduce the emissions."

The ISG unit is installed between the engine and gearbox, linked directly to the crankshaft and it replaces both the conventional starter motor and alternator. The ISG system runs from 42V and has a separate battery placed in the spare wheel bay in the luggage compartment.

"There is no need to develop a new car model or significantly modify an existing car – ISG can be integrated with most of our current models. It's a very cost-efficient system compared with other solutions such as hybrid cars," says Hans Gustavsson.

He adds: "A Volvo with ISG behaves pretty much like today's Volvos. The only noticeable differences are that the engine stops as soon as the car comes to a standstill and there are longer intervals between visits to the petrol station."

Instead of continuing to use fuel at idling – for instance when waiting at traffic lights, the engine of a car with ISG switches off completely when the vehicle is no longer in motion. When the traffic lights turn green and the driver presses the accelerator to move off, the ISG car starts instantly and almost noiselessly. ISG supplies the engine with power at the moment the car moves off and also during acceleration – when the car would otherwise require extra fuel to be injected into the engine.



Volvo S80

VOLVO
Volvo Car Corporation

ISG remains active throughout the driving process, for example during overtaking or at other times when extra power is needed.

"In certain situations, the ISG-equipped car feels even more responsive than a corresponding car with conventional motor. For instance, you can drive at low revs in a high gear. The basic principle behind ISG is that the combustion engine should work as little as possible, in order to cut fuel consumption and exhaust emissions," says Hans Gustavsson.

"Free" energy to the battery

When you lift off the accelerator pedal to slow down, the car's forward movement powers the ISG unit, which in turn recharges the 42V battery with free energy.

The Integrated Starter Generator is therefore far more efficient than a conventional alternator and this is another contributory factor to the low fuel consumption.

This also means that systems such as power steering and air conditioning, which are normally powered by the combustion engine can be powered by the 42V battery instead.

The air-conditioning system thus continues to remain active even when the engine switches off.

This is a benefit that many of Volvo's competitors cannot offer in their own ISG projects. **SC**

Automatic single channel light dimmer

. . . dimming with the power of a PIC

Pt.1: By JOHN CLARKE

This single-channel fully automatic high-power light dimmer has a host of control features because it is driven by a PIC microcontroller. It will drive incandescent lamp loads up to a total of 2400 watts.

THE SILICON CHIP Touch/Remote Controlled Dimmer, described in the January and February 2002 issues, was a low power device, suitable for lamp loads up to 250W. That's OK for dimming the lights in your lounge room or bedroom but useless for dimming high power stage lights or a bank of lights in a hall or church.

For that purpose you need a high power dimmer and that is the reason for this completely new design. It is specially designed to drive the high power lamps used in stage lighting, up to a total of 2400W. It has all sorts of control features such as preset brightness levels, dimming rates, flash on and off buttons and so on.

Our last high power dimmer, featured in the August 1994 issue, was a fairly basic design with just a slider knob to control the brightness. This new design has no slider knob but can dim up or down manually or automatically and has LED bargraphs to indicate the brightness levels, dimming rates and more.

SPECIFICATIONS

Maximum lamp power	2400W
Minimum lamp power	60W (lower power lamps may flicker)
Phase angles	5.8° for maximum brightness and 174° for minimum brightness
Auto Dimming rates	0, 0.5s, 1s, 1.5s, 2s, etc in 39 steps up to 40s maximum
Dimming steps	102 typical beyond initial preheat setting up to full brightness
Dimming display	39 levels
Triac gate drive period	80µs

Features

The SILICON CHIP Automatic Light Dimmer is housed in a rugged diecast metal case measuring 170 x 120 x 55mm. We used a diecast metal box for two reasons: first because stage light dimmers often have a rugged life and second, the case provides heatsinking for the Triac which is the power control device at the heart of the circuit.

At one end of the case is the 240VAC mains cord, a 3-pin mains socket for the lamp, a power switch and a fuse holder. On the front panel are two LED bargraphs, a large LED brightness indicator and no less than eight switches of various sorts.

Along the bottom edge of the control are three rocker switches, two of which are spring-loaded centre-off types. Want to dim the lights up or down? Use the DIM switch in the lefthand corner. Push it up to go brighter; down for dimmer.

Want to flash the lights to full brilliance? Push the FLASH switch on. Want to flash them off? Push the FLASH switch off. This can be done at any time, regardless of other settings or modes.

Dimming can be manual or automatic, depending on the setting of the Automatic/Manual Dimming switch in the right-hand corner. When dimming automatically, pushing the DIM switch UP lets the lamp(s) brighten up to the preset brilliance. Pushing the DIM button DOWN, dims the lamp(s) back down to zero.

Brightness can be preset to one of 39 brightness levels with the LEVEL UP/DOWN rocker switch. Brightness levels are indicated on a 20-LED bargraph. Yes, we know we said there are 39 brightness levels? So how do you indicate 39 levels with 20 LEDs? The trick is that we use 20 LEDs to indicate 20 levels from maximum to minimum but the intermediate brightness levels are indicated with two adjacent LEDs – its harder to describe than to use.

So as the level is increased, we get one LED, then two adjacent LEDs, then the top one of that adjacent pair, then the next adjacent pair and so on. This one-two-one LED sequence indicates 39 levels.

The same 20-LED bargraph can also show the Flash brightness setting which is preset using the DIM/FLASH switch, in conjunction with the up/down rocker switch to the left of the bargraph.

Filament preheat

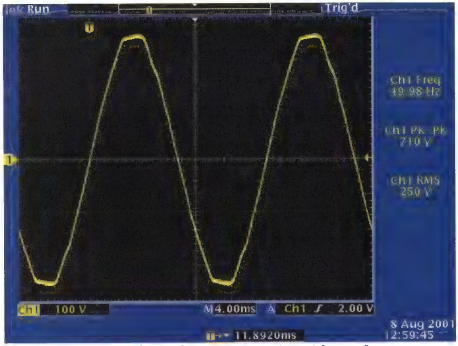
When high power lamps are initially switched on, their cold filaments have a very low resistance and so they have very high surge currents. This is bad enough at switch-on but if a lamp is to be repeatedly flashed on, as it can be with this dimmer, then the repetitive surge currents can destroy the Triac and also blow out the filament of the lamp itself. To reduce this problem, the lamp filament is always run with a low value of "preheat" current, typically with the filament glowing a dim red.

Preheat setting is done by pressing the DIM UP, LEVEL UP and Store Settings switches all together. We will discuss this later in this article.

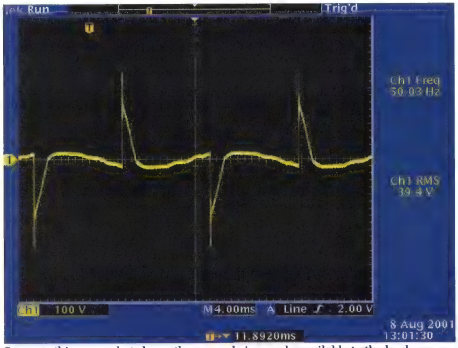
The actual lamp brightness is indicated in two ways on the display. Firstly, there is a large 10mm LED which glows according to the lamp brightness. Second, the 20-LED bar-

MAIN FEATURES

- High power lamp control
- Maximum lamp brightness preset
- Minimum lamp brightness preset for filament preheating
- Automatic or manual dimming between brightness presets
- Separate flash on and flash off
- Flash brightness preset
- Dimming rate programmable from instant through to 40 seconds
- A and B dimming rate selection
- Lamp brightness indication
- Automatic dim up and dim down indication



Scope 1: this somewhat distorted mains sinewave is straight out of a power point. While nominally 240V AC, 50Hz, in this case it's actually 250V AC and the frequency is just a tad low (neither of which is unusual).



Scope 2: this scope shot shows the power being made available to the load very late in the half cycle so that it effectively receives just under 40V. In this case, the lamp would be barely glowing.

graph indicates actual brightness and preset brightness levels. Actual lamp brightness is shown with a flashing LED in the bargraph, while the DIM or FLASH preset levels are shown by a constant LED. If the two levels are the same, the indicating LED will shimmer rather than glow constantly.

By the way, all the LED indications in the two bargraphs are in "dot" mode – ie, single LEDs glowing – rather than "bar" mode.

When dimming automatically, dimming can be stopped at any time by momentarily pressing the DIM UP/DOWN switch in the opposite direction to the dimming. So if the lamp is in the process of dimming up, dimming can be stopped by momentarily pressing the DIM DOWN switch. If this switch is held down or pressed again, then the dimmer will begin dimming down. Similarly, if dimming down in auto mode, dimming can be stopped by momentarily pressing the DIM UP switch.

Dimming rate

Automatic and manual dimming occurs at a preset RATE. You can set two dimming rates (A and B) with each one ranging from instantaneous to 40 seconds, in 0.5s increments, as displayed on the right-hand bargraph. The topmost LED indicates the longest dimming time and therefore the slowest rate.

When automatic dimming is in progress, the topmost LED in the Rate 20-LED bargraph display flashes for dimming up while the lowest LED flashes when dimming down.

Some controls cannot be used when dimming is in process. These are the Level Up/Down, Rate Up/Down and Store Settings switches. These switches are locked out of service during dimming to prevent any possible lamp flickering which may happen if there is any attempt to operate several functions at the one time.

The A and B dimming rate settings, the Dim and Flash presets and the minimum level preheat setting can be stored so that these settings will be remembered when the dimmer is used next time, after being switched off. This is done by pressing the "Store Settings" switch.

In fact, it is important to press this switch after the minimum level filament preheat has been set so that this will always be set correctly. During this time, the LED bargraph display momentarily goes off as an acknowledgement that storage has taken place.

When ever the dimmer is first switched on, the lamp brightness is set to fully off and no filament preheating is applied. This means that no power is supplied to the lamp. The dimmer will begin to provide power

PLEASE NOTE!

The scope waveforms in this article are shown to explain the operation of the circuit. DO NOT try to reproduce these waveforms yourself – it is much too dangerous.

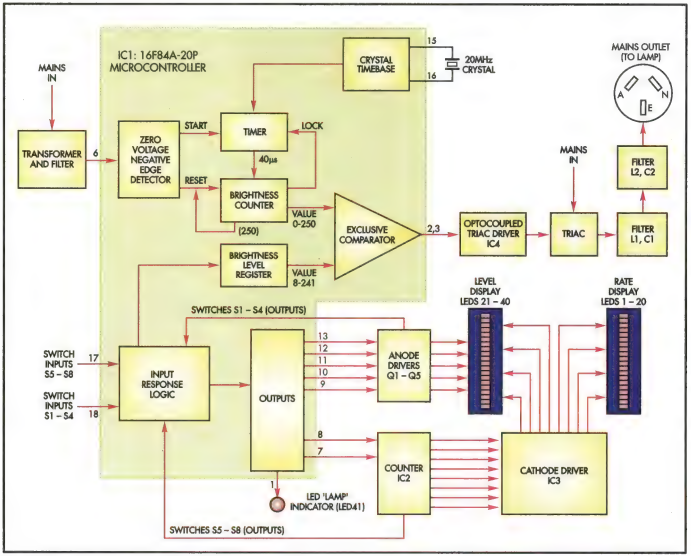


Fig.1 the block diagram of the Auto Dimmer circuit. The key device is the PIC16F84A-20/P microcontroller. It accepts inputs from the transformer and switches and provides outputs to switch a Triac and drive the LED displays.

to the lamp as soon as the Flash or Dim switches are pressed.

Phase-controlled Triac

As with any light dimmer, the circuit uses a phase-controlled Triac to set the lamp brightness. The principle is virtually the same as outlined in the January 2002 article on the Touch-controlled Dimmer. For those readers who did not see that article, we will go through the details again.

Our mains electricity supply is a 240VAC 50Hz sinewave which goes positive for 10ms, back through zero and then negative for 10ms. This returns to zero and again goes positive. Normally a lamp is connected across this supply whenever it is switched on.

In a dimmer circuit, we delay applying power to the lamp during each half-cycle of the mains waveform and switch it off each time the voltage goes through zero to effectively provide less power and so dim the lamp.

This timed switching of the power is performed by a Triac which can be triggered on by a short pulse at its gate. The Triac will then only turn off when the current through it drops below a certain threshold value. In practice, when driving a resistive load this means that the Triac switches off when the mains voltage is near 0V. The accompanying oscilloscope waveforms, repeated from the January 2002 issue, show how it works.

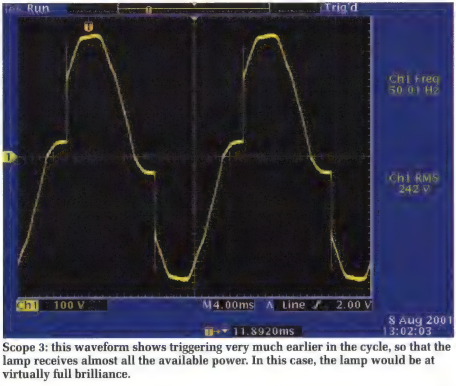
The first oscilloscope waveform (Scope 1) is the mains sinusoidal voltage measured on the Active output of a power point. Note that the mains voltage shown here is closer to 250VAC and it is by no means unusual to have such a high voltage.

The second oscilloscope waveform (Scope 2) shows the waveform applied to the lamp when it is dimmed to a low brightness. In this case, the lamp is powered about 150° from the start of each mains half-cycle and is switched off at 0V.

Note that the lamp voltage is applied for both positive and negative excursions of the mains active and the RMS voltage is around 39V.

The third oscilloscope waveform (Scope 3) shows the lamp voltage when the dimmer is set for close to maximum brightness. Now the voltage is switched on early in each mains half-cycle so that almost the full mains waveform is applied. Again the lamp is switched off at 0V. The RMS voltage is now a lot higher, at 242V.

The circuit for the lamp dimmer obtains this phase control by dividing



Scope 3: this waveform shows triggering very much earlier in the cycle, so that the lamp receives almost all the available power. In this case, the lamp would be at virtually full brilliance.

up each half cycle (180°) of the mains waveform into 250 discrete sections. Thus, each discrete section is equivalent to 0.72° (180/250).

The overall range of phase control in the dimmer circuit is restricted to a minimum count of 8 (5.8°) and a maximum count of 241 (174°).

Block diagram

Fig.1 shows the general arrangement of the dimmer circuit. The key device is the PIC16F84A-20/P microcontroller. It accepts inputs from the transformer and switches and provides an output to switch the Triac. Its other outputs drive the LED displays.

IC1 operates from a 20MHz timebase and this clocks a timer which counts up until it reaches 40µs. The output then clocks the brightness counter which counts from 0 through to 250 for each 10ms half-cycle of the mains voltage. This is locked to the mains waveform via the zero voltage negative edge detector which resets the brightness counter to zero each time the mains voltage drops to zero.

An important part of this circuit is the feedback from the brightness counter back to the internal timer. This is required to lock the internal timer rate to the brightness counter and adjusts so that the counter is just on the verge of counting to 250 at the occurrence of the zero voltage signal from the mains. Any deviation from this locked arrangement will produce flickering in the phase controlled lamp.

The current required lamp brightness is stored in the brightness level register and this value is compared with the brightness counter value using an exclusive comparator. The exclusive comparator output drives the optocoupled Triac driver (IC4) when both the brightness counter and the brightness level register are the same value.

Input signals from switches S1-S8 provide the controls to set the dimming brightness, flash brightness, dimming rate and so on, as described above. Input response logic decides what action to take when one of these switches are pressed.

Circuit diagram

The circuit for the Automatic Dimmer is shown in Fig.2. As already noted, IC1, the PIC16F84A-20/P microcontroller, is the heart of the circuit. This IC runs at 20MHz, by virtue of the 20MHz crystal (X1) connected to pins 15 & 16. It needs to run at this speed in order to perform all the necessary functions of driving the LED displays and monitoring the switches without this interfering with providing the trigger pulses to the Triac.

The two bargraphs, comprising LEDs 1 to 40, are driven via IC2, IC3 and transistors Q1-Q5. However, while the LEDs are physically arranged as two 20-LED bargraphs, they are connected in a matrix of five rows and eight columns. They are driven in multiplex fashion, under the control of IC1, IC2 and IC3.

Each of the five transistors drives the commoned anodes of its row of LEDs via a 47Ω resistor. The eight columns are each driven via a Darlington transistor in the cathode driver (IC3). Each of the eight base inputs in IC3 is driven by 4017 counter IC2 which is clocked by IC1. Only one column is driven at a time and the required LEDs in that column are driven by the row drivers, Q1-Q5.

Each time IC2 is clocked by IC1, one of its eight outputs goes high to drive IC3 to display the next column.

After the last column is lit, IC2 is clocked again so that the "8" output goes high. This output is not connected to the circuit and so all the columns (and all LEDs) are off.

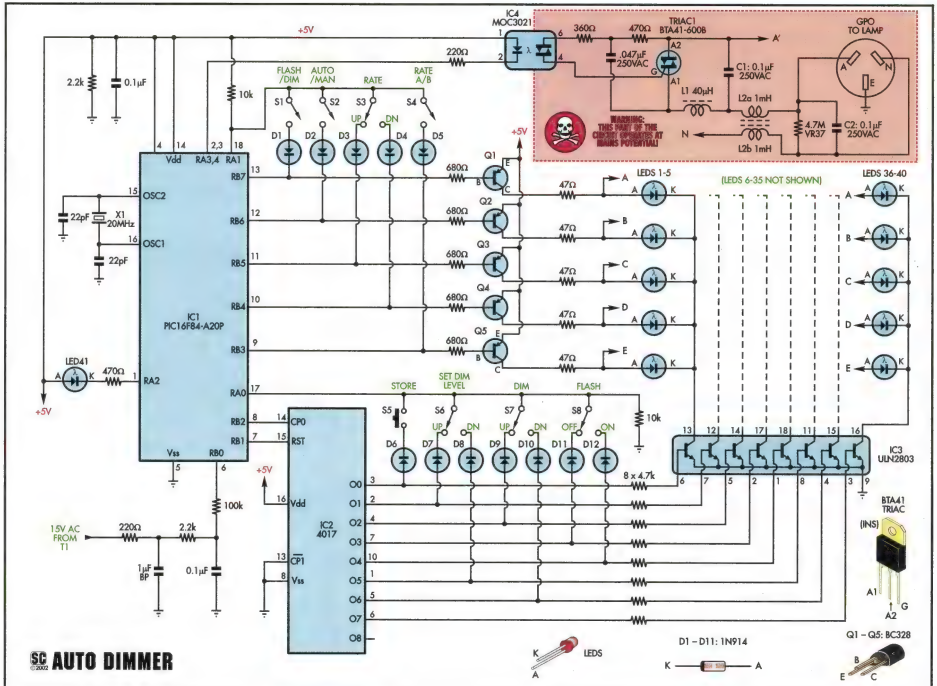
Next, IC1 checks switches S1-S4 to see if they have been operated. It does this by pulling the RB3-RB7 lines (pins 9-13) low in turn, to check if its pin 18 is pulled low via a switch and diodes D1-D5.

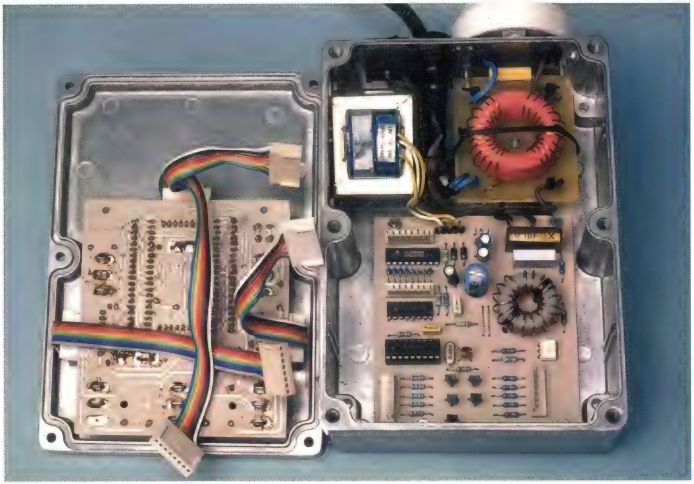
So for example, if RB7 is brought low and S1 is open, pin 18 of IC1 will remain high via the 10kΩ pullup resistor. If the switch is closed, the low RB7 output will pull pin 18 low via diode D1. The diodes ensure that the RB7-RB3 outputs are not shorted together if more than one switch is closed. Note that bringing the RB7-RB3 lines low will also drive transistors Q1-Q5, so it is important that the columns are off. This is why IC1 can only check these switches when the (unused) "8" output of IC2 is high.

After this switch test, IC2 is reset via a high RB1 signal from IC1. Now the "0" output is high to drive column 1 again. Switches S5 to S8 are tested for closure using the high outputs from IC2 and the RA0 input, pin 17, of IC1.

Normally pin 17 is held low via a 10kΩ resistor. If the "0" output (pin 3)

Fig.2 (right): the full circuit details of the Auto Dimmer. Microcontroller IC1 controls optoisolator IC4 which in turn controls Triac1 to vary the lamp brightness. It also drives transistors Q1-Q5 and IC2 to switch the LED displays.


AUTO DIMMER
IC1 PIC16F84-A20P
IC2 4017
IC3 ULN2803
IC4 MOC3021
TRIAC1 BTA41-600B
BTA41 TRIAC
GPO TO LAMP
FLASH /DIM
AUTO /MAN
RATE
RATE A/B
STORE
SET DIM LEVEL
DIM
FLASH
LEDS 1-5
(LEDS 6-35 NOT SHOWN)
LEDS 36-40
15V AC FROM T1
WARNING: THIS PART OF THE CIRCUIT OPERATES AT MAINS POTENTIAL!
LEDS
D1 – D11: 1N914
Q1 – Q5: BC328
+5V



This is the view inside the prototype with the wiring almost completed. The full assembly details will be published in Pt.2 next month.

of IC2 is high and switch S5 is closed, then RA0 will be pulled high via diode D6. If the switch is open then RA0 will remain low. Diodes D6-D12 ensure that IC2's outputs are not shorted together if more than one switch is closed.

Triac drive

The RA3 and RA4 outputs of IC1 drive IC4, the MOC3021 optocoupled Triac driver, via a 220Ω resistor. When these outputs are high, the LED inside IC4 is off. When these pins go low, the LED is driven and this activates the internal Triac between pins 4 and 6 to drive the gate of Triac1, a BTA41-600B. The gate drive current comes via 360Ω and 470Ω resistors from the 240VAC mains Active line The .047µF capacitor is included as a "snubber" to prevent false switching of the Triac by transients on the mains Active.

The gate drive pulse to Triac1 is set at 80µs which is sufficient time to ensure that it latches on for the duration of the mains half cycle.

Triac1 is a BTA41-600B, a 600V 40A device which has been specified to cope with the very high surge currents which occur when switching a 2400W incandescent lamp load. Typically, the surge current at switch-on can be 10-15 times the normal load current; ie, the surge current could be 100-150 amps and could last for several milliseconds.

WARNING!

Part of the circuitry used in this Automatic Light Dimmer operates at 240VAC (see Fig.2) and is potentially lethal. Do not touch any part of this circuit while the unit is plugged into the mains and do not operate the circuit outside its earthed metal case.

This project is for experienced constructors only. Do not build it unless you are entirely familiar with mains wiring practices and construction techniques.

The Triac must also be able to cope with the very high fault currents that occur when high power lamps blow their filaments. When this happens, the broken sections of the filament can establish an arc between the stem supports and this arc current continues until the stem fuse blows. Considering that this arc current can be many hundreds of amps, the Triac has to be very rugged.

EMC filtering

The rapid switching of the Triac, combined with high currents, means that this circuit can generate a lot of interference. So we have included a two-stage filter network comprising L1 & C1 and L2 & C2. The 4.7MΩ resistor across the Active and Neutral output discharges the capacitors when power is off to prevent these from being left charged.

The first stage in the filtering uses an powdered iron toroid for the 40µH inductor L1. This type of inductor is quite lossy for frequencies above about 1MHz and so in conjunction with the 0.1µF capacitor, it attenuates much of the electromagnetic interference (EMI)

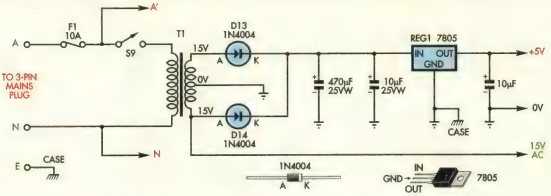


Fig.3: this simple circuit is used to derive the low-voltage AC and DC supply rails for the dimmer.

caused by the rapid switching of the Triac. However, it is not a good filter below 1MHz, particularly for frequencies between 10kHz and 100kHz which must also be attenuated to prevent EMI above the allowable limits.

This is where the second filter comes into play. It comprises a toroidal core with two windings. The core has a high permeability ferrite material so that we can obtain a much higher value of inductance without an excessive number of turns on the toroid. However, the combination of high inductance and high load current means that the core is easily saturated by the magnetic flux generated when current flows through the windings.

This is why we have two windings on the core; so that any flux generated by one winding is opposed by the second winding. This means the net magnetic flux in the core adds up to zero and so saturation does not occur. However, if we say that the flux generated by one winding is cancelled by the flux in the second, then how does the filter work?

Clearly, flux cancellation does occur for the low frequency part of the load current but for the high frequencies, which are bypassed by C2, flux cancellation does not take place and so the twin windings give a high effective inductance for the interference frequencies we are trying to get rid of.

LED brightness indication

As mentioned previously, we use a large LED on the front panel to mimic the lamp brightness. This is driven by the RA2 output of IC1 which goes low when the Triac is driven to light the LED via a 470Ω resistor. It is then switched off at the end of each mains half-cycle. Note that the drive to LED41 does not occur for the filament preheat period, where the lamps are effectively off.

Low voltage power for the circuit comes from transformer T1, as shown on the circuit of Fig.3. Its centre-tapped secondary feeds diodes D13 and D14 and the 470µF capacitor filters the DC which is fed to the 7805 3-terminal regulator, REG1. This provides the +5V rail for the ICs and the LEDs.

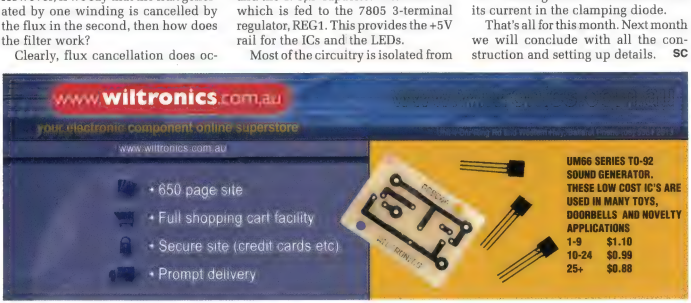
Most of the circuitry is isolated from the mains by transformer and the optocoupler IC4. **The portion of the circuit in the top right-hand corner of Fig.2 is at 240VAC mains and is potentially lethal.**

Zero crossing detection

Because IC1 must provide precisely timed trigger pulses to the Triac, it needs be synchronised to the 240VAC mains waveform. To do this, IC1 monitors the 15VAC waveform from the transformer at its RB0 input, pin 6. This is used to detect the zero crossing point of the mains voltage.

The 15VAC signal is filtered with a two-stage RC filter comprising 220Ω & 2.2kΩ resistors and 1µF & 0.1µF capacitors. This rolls of frequencies above about 700Hz to remove transients from the mains. The 100kΩ resistor to the RB0 input is included because there is a diode within IC1 which clamps the voltage when it goes 0.7V below ground. The resistor limits current in the clamping diode.

That's all for this month. Next month we will conclude with all the construction and setting up details. **SC**



WATER LEVEL INDICATOR

This simple circuit lights a string of LEDs to quickly indicate the level in a rainwater tank. It's easy to build and can be powered from an AC or DC plugpack supply.

By ALLAN MARCH

There are two traditional methods for finding the level of water in a tank: (1) tapping down the side of the tank until the sound suddenly changes; and (2) removing the tank cover and dipping in a measuring stick. The first method is notoriously unreliable, while the second method can be awkward and time-consuming.

After all, who wants to clamber up on top of a tank each time you want to find out how much water is inside it?

That's where this simple circuit comes in. It uses five green LEDs arranged in a bargraph display to give a clear indication of how the water supply is holding up. The more LEDs that light, the higher the water in the tank.

A sixth red LED lights when the tank level drops below a critical threshold.

There are no fancy microcontrollers or digital displays used in this project. Instead, it uses just a handful of common parts to keep the cost as low as possible.

Circuit description

Fig.1 shows the circuit details. It's based on an LM3914 linear LED dot/bar display driver (IC1) which drives five green LEDs (LEDs 1-5). Pin 9 of the LM3914 is tied high so that the display is in bargraph mode and the height of the green LED column indicates the level of the water in the tank.

The full-scale range of the bargraph depends on the voltage on pin 6. This voltage can be varied using VR1 from

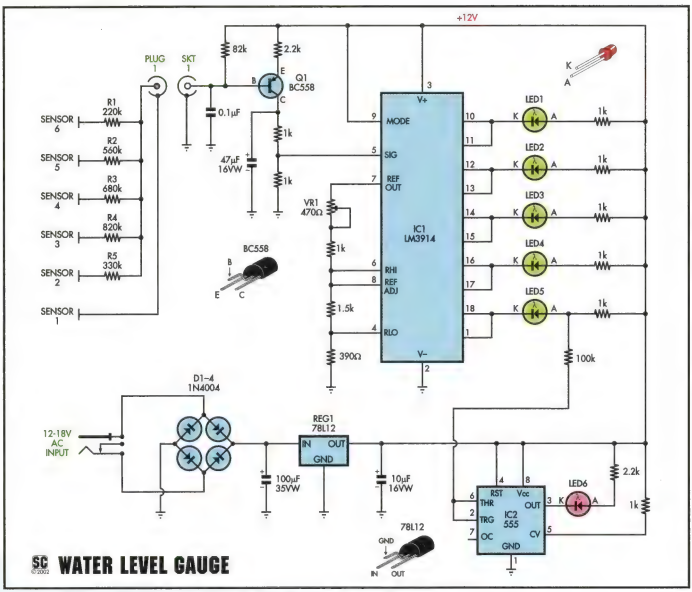


Fig.1: the circuit is based on an LM3914 dot/bar display driver (IC1) which drives LEDs 1-5. Its output depends on the number of sensors covered by water – the more covered, the higher the voltage on Q1's collector and the greater the voltage on pin 5 (SIG) of IC1. LED6 provides the critical level warning.

about 1.61V to 2.36V. After taking into account the voltage across the 390Ω resistor on pin 4, this gives a full-scale range that can be varied (using VR1) between about 1.1V (VR1 set to 0Ω) and 2V (VR1 set to 470Ω).

By the way, if you're wondering where all the above voltages came from, just remember that IC1 has an internal voltage reference that maintains 1.25V between pins 7 & 8. This lets us calculate the current through VR1 and its series 1kΩ resistor and since this same current also flows through the series 1.5kΩ and 390Ω resistors, we can calculate the voltages on pins 6 and 4.

As well as setting the full-scale range of the bargraph, VR1 also adjusts the brightness of LEDs 1-5 over a small range. However, this is only a secondary effect – it's the full-scale range that's important here.

IC1's outputs directly drive LEDs 1-5 via 1kΩ current limiting resistors. Note, however, that an LM3914 has 10 comparator outputs but we only need five steps for this application. That's done by wiring the outputs of successive comparator pairs in parallel – ie, pins 1 & 18 are wired together, as are pins 17 & 16 and so on.

Water level sensor

The input signal for IC1 is provided by an assembly consisting of six sensors located in the water tank and connected to the indicator unit via light-duty figure-8 cable. This sensor assembly relies on the fact that there is a fairly low (and constant) resistance between a pair of electrodes in a tank of water, regardless of the distance between them.

As shown in Fig.1, sensor 1 is connected to ground, while sensors 2-5 are connected in parallel to the base of PNP transistor Q1 via resistors R5-R1. Q1 functions as an inverting buffer stage and its collector voltage varies according to how many sensor resistors are in-circuit (ie, how many sensors are covered by water).

When the water level is below sensor 2, resistors R5-R1 are out of circuit and so Q1's base is pulled high by an 82kΩ resistor. As a result, Q1 is off and no signal is applied to IC1 (ie,

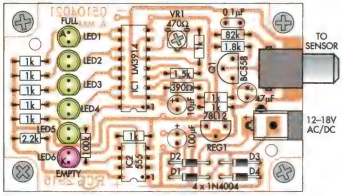


Fig.2: follow this diagram when installing the parts on the PC board. Note that some parts have to be omitted for 12V battery operation – see text.

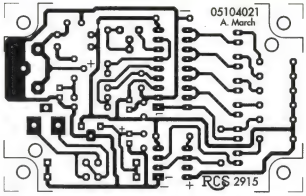


Fig.3: this is the full-size etching pattern for the PC board. Check your board carefully before installing any of the parts.

LEDs 1-5 are off). However, if the water covers sensor 2, the sensor end of resistor R5 is essentially connected to ground. This resistor and the 82kΩ resistor now form a voltage divider and so about 9.6V is applied to Q1's base.

As a result, Q1's emitter is now at about 10.2V which means that 0.8mA of current flows through the 2.2kΩ emitter resistor. Because this same current also flows through the two 1kΩ collector load resistors, we now get about 0.8V DC applied to pin 5 (SIG) of IC1. This causes pins 1 & 18 of IC1 to switch low and so the first green LED (LED5) in the bargraph lights.

As each successive sensor is covered by water, additional resistors are switched in parallel with R5 and Q1's base is pulled lower and lower. As a result, Q1 turns on "harder" with each step (ie, its collector current increases) and so the signal voltage on pin 5 of IC1 increases accordingly. IC1 thus progressively switches more outputs low to light additional LEDs.

Note that Q1 is necessary to provide a reasonably low-impedance drive into pin 5 (SIG) of IC1, while keeping the current through the water sensors below the level at which electrolysis becomes a problem.

Critical level indication

IC2 is a 555 timer IC and it drives LED6 (red) to provide a warning when the water level falls below the lowest sensing point; ie, when all the green LEDs are extinguished. However, in this role, IC2 isn't used as a timer. Instead, it's wired as a threshold detector and simply switches its output at pin 3 high or low in response to a signal on its threshold and trigger inputs (pins 6 & 2).

It works like this: normally, when there is water in the tank, LED5 is on and its anode is at about 2V. This "low" voltage pulls pins 6 & 2 of IC2 low via a 100kΩ resistor, so that these two pins sit below the lower threshold voltage. As a result, the pin 3 output of IC2 is high and LED6 is off.

However, if the water level falls below sensor 2, LED5 turns off and the anode of LED5 "jumps" to +12V. This voltage exceeds the upper threshold voltage of IC2 and so pin 3 switches low and LED6 turns on to give the critical low-level warning.

Note that the control pin (pin 5) of IC2 is tied to the positive supply rail via a 1kΩ resistor. This causes IC2 to switch at thresholds of 0.46Vcc (5.5V) and 0.92Vcc (11V) instead of the usual $\frac{1}{3}$Vcc and $\frac{2}{3}$Vcc and is necessary to ensure that IC2 switches correctly to control LED6.

Power for the unit is derived from a 12-18VAC plugpack supply. This drives a bridge rectifier D1-D4 and its output is then filtered using a 100μF electrolytic capacitor and applied to a 12V 3-terminal regulator (REG1). The output from REG1 is then filtered using a 10μF electrolytic capacitor and used to power the circuitry.

Note that a regulated supply rail is necessary to ensure that the water level

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	820kΩ	grey red yellow brown	grey red black orange brown
❑	1	680kΩ	blue grey yellow brown	blue grey black orange brown
❑	1	560kΩ	green blue yellow brown	green blue black orange brown
❑	1	330kΩ	orange orange yellow brown	orange orange black orange brow
❑	1	220kΩ	red red yellow brown	red red black orange brown
❑	1	100kΩ	brown black yellow brown	brown black black orange brow
❑	1	82kΩ	grey red orange brown	grey red black red brown
❑	2	2.2kΩ	red red red brown	red red black brown brown
❑	1	1.5kΩ	brown green red brown	brown green black brown brown
❑	9	1kΩ	brown black red brown	brown black black brown brown
❑	1	390Ω	orange white brown brown	orange white black black brown

indication doesn't change due to supply variations.

Construction

Construction is straightforward, with all the parts installed on a PC board coded 05104021 and measuring 80 x 50mm. This is installed in a standard plastic case, with the LEDs all protruding through the lid.

Fig.2 shows the parts layout on the PC board. Begin the assembly by installing the resistors, diodes and capacitors, then install the ICs, transistor Q1 and the 3-terminal regulator (REG1). Make sure that the diodes and ICs are installed the right way around.

The same applies to the electrolytic capacitors – be sure to install each one with its positive lead oriented as shown on Fig.2.

Trimpot VR1 can now be installed, followed by the RCA socket and the 2.5mm power socket. The two sockets are both PC-mounting types and mount directly on the board.

The LEDs are fitted last and must be installed so that the top of each LED is 33mm above the PC board. This ensures that the LEDs all just protrude through the lid when the board is mounted in the case on 10mm spacers. Make sure that all LEDs are correctly oriented – the anode lead is the longer of the two.

Dot operation

You can easily convert the LM3914 (IC1) from bar to dot operation if that's what you prefer. All you have to do is cut the thinned section of track immediately to the left of the 0.1µF capacitor and install a wire link between the two vacant holes at the top of the board near IC1. Alternatively, the link can be omitted (ie, pin 9 can be either pulled low or left open circuit).

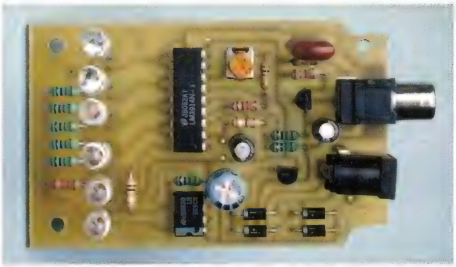
Battery operation

If the unit is intended for 12V battery operation in a mobile home or caravan, regulator REG1 and diodes D2, D3 & D4 are omitted. Both D4 and REG1 are then replaced by wire links – ie, install a link instead of D4 and install a link between the IN & OUT terminals of REG1.

D1 remains in circuit to protect against reverse battery connection.

Metal tanks

If the tank is of made of metal, you can dispense with Sensor 1 and connect the tank directly to the circuit ground. You must also ensure sensors 2-6 do not touch the walls of the tank. This can be done by slipping a length of 25mm-OD clear PVC tubing over the completed probe, securing it at the top so that the water inside can follow the level in the tank.



The power socket and RCA connector are both mounted directly on the PC board. Make sure that all parts are correctly oriented and that they are in the correct locations.

The PC board in secured to the bottom of the case using two 10mm standoffs at one end, while the RCA socket provides the support at the other end.

Final assembly

The PC board is mounted in the bottom of the case on two 10mm standoffs and is secured using 3mm machine screws, nuts and washers. Note that the corners at one end of the PC board must be removed to clear the pillars inside the case.

You will have to remove these corners yourself using a small hacksaw and rat-tile file if this hasn't already been done.

Fig.6 shows the locations of the two board mounting holes in the bottom of the case. You will also have to drill two holes in one end of the case, so that they line up with the RCA socket and the power socket when the board is installed (see Fig.6).

The front-panel artwork (Fig.5) can be used as a template for drilling the front panel. There are six holes to be drilled here – one for each LED – and these are all 5mm-dia. It's a good idea to countersink these holes from the underside of the lid using a 6mm drill, so that the LEDs slip easily into position when the lid is fitted.

Sensor assembly

The sensor assembly is made by threading six lengths of 1mm enamelled copper wire through 8mm OD

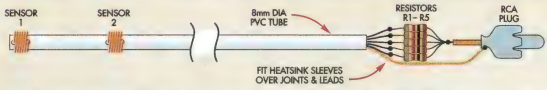


Fig.4: the water level sensor is made by threading six lengths of 1mm enamelled copper wire through 8mm OD clear PVC tubing (see text). The six sensors should be evenly spaced down the tube.

clear PVC tubing – see Fig.4. This tubing should be long enough to reach the bottom of the tank, with sufficient left over to fasten the top end securely. The reason for using 1mm wire is primarily to make it easy to thread it through the plastic tube.

Parts List

1 PC board, code 05104021, 80 x 50mm
1 plastic case, 130 x 67 x 44mm
1 PC-mount RCA socket
1 RCA plug
1 2.5mm PC-mount power socket
1 12V AC 500mA plugpack
1 100gm spool 1.0mm enamelled copper wire
1 length 8mm-OD clear PVC tubing to match height of tank plus 200mm
2 3mm x 20mm screws and nuts
2 10mm spacers

Semiconductors
1 LM3914 linear dot/bar driver (IC1)
1 NE555 timer (IC2)
1 BC558 PNP transistor (Q1)
1 78L12 12V regulator (REG1)
4 1N4004 diodes (D1-D4)
5 5mm green LEDs (LEDs1-5)
1 5mm red LED (LED6)

Capacitors
1 100µF 35VW PC electrolytic
1 47µF 16VW PC electrolytic
1 10µF 16VW PC electrolytic
1 0.1µF greencap

Resistors (0.25W, 1%)

1 820kΩ	1 82kΩ
1 680kΩ	2 2.2kΩ
1 560kΩ	1 1.5kΩ
1 330kΩ	9 1kΩ
1 220kΩ	1 390Ω
1 100kΩ	1 470Ω trimpot

Miscellaneous
Light-duty figure-8 cable, 2.5mm PVC sleeving, heatshrink tubing.

The top sensor (S6) is placed about 100-150mm below the overflow outlet at the top of the tank, while the other sensors are spaced evenly down the tube.

Begin by using a 1.0mm drill to drill holes through the tube wall at the appropriate points, including a hole for the bottom sensor (S1) to hold it in place securely. That done, you can thread the wires through by pushing them through the drilled holes and then up the tube. You will find that the wire goes in more easily if the PVC tube is bent at an angle so that the drilled hole is in line with the bore of the tube.

The end of each wire should also be smoothed before pushing it into the tube, to avoid scratching the enamel of the wires already in the tube. Leave about 150mm of wire on the outside of the tube at each point.

It's a good idea to trim each successive wire so that it protrudes 20mm further out of the top of the tube than its predecessor. This will allow you to later identify the individual wires when attaching the resistors.

When all six wires have been installed, the next step is to solder the wire for S1 to the "earthy" side of the figure-8 lead, cover it with insulating sleeving and pull the covered joint down about 50mm into the 8mm tube. This done, the resistors can be soldered to their appropriate wires.

Push about 15mm of 2.5mm sleeving over each wire before attaching its resistor. This sleeving should then pulled up over the joint and the bottom end of each resistor after it is soldered. Once all the resistors have been soldered, the wires should be pulled down so that the joints are just inside the 8mm tube, as shown in the photo.

When this process is complete, there will be five resistors protruding from the top of the 8mm tube. Their re-

This is the author's completed water level sensor. A weight can be attached to the bottom end to keep the plastic tube straight when it is immersed in the tank.

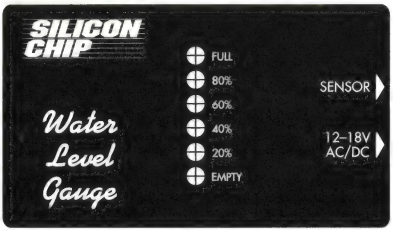


Fig.5: this full-size artwork can be used as a drilling template for the front panel.

Improved Water-Level Sensor

For a long-life water level sensor, Bob Barnes of RCS Radio suggests that the probe be made out of 19mm plastic conduit fitted with stainless-steel radiator or fuel pump hose-clamps for the sensors.

Suitably sleeved nichrome or stainless steel wire ("up the spout") can then be used to make the connections between the clamps and the resistors.

You will need to use Multicore Arax cored solder or Litton Arax cored solder (available from Mitre-10) when soldering nichrome or stainless steel wire (ie, a corrosive flux is needed). You can buy nichrome wire from Dick Smith Electronics or from Jaycar, while stainless steel wire should be available from boating suppliers.

The top of the water level sensor can be secured to the tank using a suitable bracket,

maining leads are then twisted together, soldered to the other side of the figure-8 cable and covered with heatshrink tubing. The other end of the figure-8 cable is fitted with an RCA plug, with the resistor lead going to the centre pin and the sensor 1 lead going to the earth side of the connector.

The next step is to scrape away the enamel from the 150mm wire lengths at each sensor point and wind them firmly around the outside of the tube. A 30mm length of 12.5mm copper water pipe can be pushed over sensor 1 to add weight and increase the surface area if desired.

Note: on no account should solder be used on the submersible part because corrosion will result from galvanic action.

Finally, the end of the plastic tube and the holes can be sealed with neutral-cure silicone sealant. However, don't get any silicone sealant on the coiled sensor wires, as this will reduce the contact area (and perhaps render them ineffective).

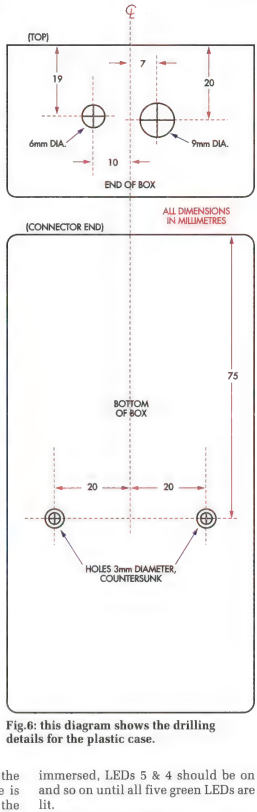


Fig.6: this diagram shows the drilling details for the plastic case.

Switching on

Now for the big test. Apply power to the unit and check that the red LED comes on and that there is +12V on pin 3 of IC1. If all is well, the unit can now be tested by connecting the sensor assembly and progressively immersing it (starting with sensor 1) in a plastic dish that's full of water. When sensor 1 and sensor 2 are immersed, LED6 should extinguish and LED5 should come on.

Similarly, when sensors 1, 2 & 3 are immersed, LEDs 5 & 4 should be on and so on until all five green LEDs are lit.

Finally, trimpot VR1 must be set so that the appropriate LEDs light as the sensors are progressively immersed in water. In practice, you should find the two extremes of the pot range over which the circuit functions correctly, then set the pot midway between these two settings. **SC**

SERVICEMAN'S LOG

Who said servicing was dying?

Well, maybe it is but my bench is still full. In fact, I have quite a collection of stories this month for no less than 10 different models. Fortunately, several were short and fairly straightforward.

I have a full house this month, starting with a 1999 Panasonic TC-14S15A (MX5 chassis). It was dead and the horizontal output transistor Q551 (2SD2499) was short circuit. A new one was fitted but it became extremely hot. The horizontal output transformer T501 was also replaced and all the components around the horizontal output stage were checked thoroughly. Nothing amiss was found but it was still blowing the transistor.

The only clue was a some ringing around the positive horizontal pulse on the collector of the horizontal output transistor. This problem was solved only when a sister set was brought in and the two compared. A smart pair of eyes noticed that there were four ferrite beads fitted on the good set – L552 in the emitter, L558 in the base and L551 & L557 in the collector. In the crook set, someone in the factory had left out L551 and L552 and fitted only links.

The question is, how did it last for so long before it reached this stage, because the transistor was very hot? Anyway, the ferrite beads fixed it quick smart and the transistor now runs quite cool.

Another Panasonic

At about the same time, a similarly aged (1999) Panasonic TV set also came in with a similar fault; ie, it was dead with the horizontal output transistor short circuit. This model was a more upmarket TAU set, model TX-79P100Z with an MD2 chassis, and advanced features such as computer and DVD inputs (B-Y & R-Y), etc, which one might expect at $4700.

The cause of the failure was unusual, as the frequency of the horizontal drive was far too high. In fact, it was double the correct frequency. Surprisingly, it wasn't the jungle IC that was the culprit. Rather, it was the Digibox that had somehow become stuck in the 100Hz mode. This module is non-serviceable and was replaced under warranty which fixed the problem.

A mysterious customer

Mr Armstrong was a rather mysterious customer. He was a single man in his late thirties and spent a lot of time travelling overseas. And he was on his way to another overseas trip so there was no forwarding address – just a mobile telephone number.

He brought in an Hitachi 5-inch LCD/Video Cassette Recorder VT-LC50EM (AU) which was completely dead. This is a rather nice little toy, consisting of a truly portable battery operated miniature multi-system TV receiver and VHS video system, all in a neat 370 x 90 x 220mm case. It was a set I had never seen before.

Mr Armstrong was convinced that it was just a fuse or switch and left it with me after I had checked the external AC adaptor/charger (VM-AC600EM) was delivering a healthy 9.6V DC from a rather frayed cord.

I knew immediately that this wasn't going to be simple; it was far too compact and it would be like a notebook computer – all surface mounted components and tricky access. I shot around to my mate who is an Hitachi agent and borrowed his service manual(s) – and that's when I started having second thoughts.

Maybe I had been too courageous in taking on this repair? Mr Armstrong had given me the impression that the unit was only a few years old and so I was rather disillusioned when I found out that it was in fact nearly 12 years old.

The first thing I did was to confirm that the 2Ah 9.6V nicad battery, VM-BP63, was completely shot and that a new one was rather expensive and obtainable only from Hitachi.

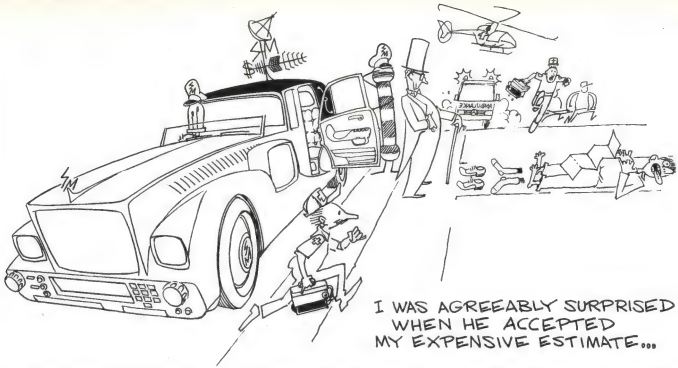
A tape was also stuck inside but the video cassette was unable to eject it or even show any signs of life.

I removed the bottom cover by undoing seven screws to reveal just what I had expected – a fair whack of miniature electronics in a small box. After a little careful reconnaissance and surfing the service manual, I discovered that there are two main boards on the left looking from underneath – ie, PC boards JAS and TTS – plus a further board (SWS) on the right under the video deck. The TTS board could be unclipped and folded upwards to give access to the JAS board below.

Of course, the boards were double-sided with surface-mount components – but the thing I noticed most, which filled me with fear, was the vast number of subminiature electrolytic

Items Covered This Month

- Panasonic TC-14S1SA TV set (MX5 chassis)
- Panasonic TX-79P100Z TV set (MD2 chassis)
- Hitachi 5-inch VT-LC50EM (AU)
- Sony KV-XF29M35 TV set
- Panasonic NV-FS90A TV set
- Sony KV-XF29M35 TV set
- Philips 28CE1965 TV set
- Philips 28GR6775/75R TV set
- Sony KV-1415AS TV set
- NEC N-3452 VCR



capacitors, many of which were leaking electrolyte on all the boards.

At this stage, all I was intending to do was to diagnose the fault(s) so that I could give Mr Armstrong a quote for the repair cost. I already had a good idea what had happened but I was determined to cross a few "t"s and dot a few "i"s. And I needed to know where the power came in and where it went, which I thought was going to be fairly simple.

It wasn't. The circuit was very complex and it took a long time to work out that the AC adaptor came in via JK1501. The battery came in via PG502 and the line then went via fuses FU1501 and FU501. These are 2A picofuses and both had blown.

The fuses, which look like resistors, were located some distance away from the DC jack and battery input. Unfortunately, it was too difficult to trace the path, not only because the board was double-sided but also because the parts were tightly packed.

Even with the fuses blown, there were voltages that could be measured at random on all the boards at places that were accessible. Unfortunately, replacing the fuses had no positive effect – the unit was still as dead as a doornail.

Next, I followed one rail from the fuses to the TTS board and then to another switchmode power supply. In the process, I checked a lot of other fuses but I was getting nowhere.

By now, I was feeling rather frustrated. All I had achieved so far was to find two open circuit fuses and determine that there was no 5.1V where it should have been. Nor was the 9.6V reaching pin 11 of IC581, the switching regulator. What's more, there were a lot of electrolytic capacitors to replace.

I then checked some of the IC regulators that fed the microcontrollers, to find they were OK (eg, IC1902 that fed IC1901 on the TTS board; and IC906 to IC901 on the SWS board which controls the power-on function).

By now, I could see that a lot of work was needed to replace the electros and possibly fix the corroded tracks underneath them. Then there was the NiCad battery, plus the memory back-up lithium battery. After adding 10% GST, I thought it hardly worth continuing with what was essentially a toy.

Anyway, I had to wait a few months before I could finally contact Mr Armstrong, when he resurfaced back in Australia. I was agreeably surprised when he accepted my expensive estimate. I guess he is one of those blokes who doesn't have many other interests and this was one of the luxuries he felt he had to have.

While waiting for his verdict, I had been planning my campaign of attack and now I was ready to go. First, I removed his jammed video tape by unplugging the loading motor (CN904) and connecting a 9V battery to it to release the tape.

That done, I concentrated on changing the worst of the electrolytic capacitors. There were 10 brown electrolytics, eight of which were 47µF 16V (C584, C587, C588, C589, C597, C1855, C1857 & C1939) and there were also two at 100µF (C585 and C586). C1855 and C1857 had corroded the tracks badly underneath and it took a lot of effort to work out which "microthin" tracks were which. The main one was VDET from PG1902-6 to pin 22 of IC1901 via R1958 and pin 1 of D1901.

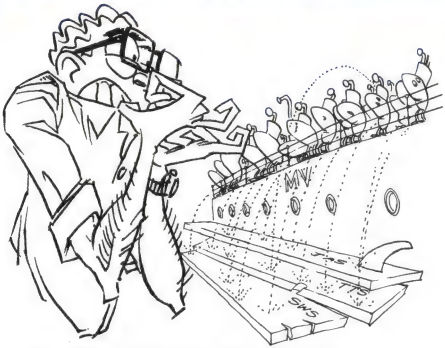
Unfortunately, I wasn't having much luck and still couldn't get the power switch to work – or even get the power-on LED to light.

I have to confess that much of my work was done with the unit upside down and I was operating the power switch by toggling it with my fingers under the half-opened LCD screen lid. After changing a few more electros, it was getting late so I thought I would clear the bench and partially reassemble the unit, ready for the next day.

That done, I turned the unit over, opened the lid fully and was staring at it hatefully while I again hopelessly pushed the power switch. To my total amazement, the whole lot came on – even the video system was working. I tuned in a channel (when I worked out how to do it!) and the picture and sound were perfect.

When I came in the next day, I couldn't help feeling that it had all been a mirage – but it was still working!

What I hadn't realised before was that the set would only work when



the screen was fully opened. There is another panel switch (S2801) – not mentioned in the manual – on the LCD board that controls pin 17 of IC1901. So I'm no too sure just when the set had actually been fixed as I worked on it.

There was no question that the screen was fully open at the start and the set was definitely "no go" then!

The problem was that the power switch doesn't just switch the power straight on. The power switch (S017, FSW board) controls IC1901-18 on the TTS board which, if everything is OK, will somehow talk to IC901. IC1901-61 then "wakes up" Q904 and activates IC901-49 on the SWS board. And that in turn switches on Q581, Q585, Q582 and IC581 on the JAS board which then switches on regulator transistors Q588-Q591

Of course, that's all assuming that nothing is wrong and that the protection circuits don't switch on!

In the future, jobs like this are definitely for the birds.

Seaside problems

Disasters can happen to everyone and to every type and make of set. Mr Byron had one such experience with a newish (1999) Sony KV-XF29M35, which lived with him in a stylish mansion by the sea.

I guess one can have too much of a good thing, because the humid salty sea breeze plays havoc with anything containing metal and electricity.

Inevitably, his set died prematurely and ended up on my bench. The power supply was dead and blowing IC601 (STR-F6656) repeatedly. I checked for shorts on the secondary of the chopper transformer and found the horizontal output transistor, Q511 (2SC-4927-01), was short circuit also but this didn't stop the switchmode control IC from destroying itself. It was only after I had committed the third IC to the bin that I woke up to the fact that the sensor amplifier, SE-135N (IC602), was giving incorrect feedback information.

However, I wasn't completely out of the woods. The picture was extremely dark, with no contrast. And the horizontal output transformer, T503, was looking particularly dodgy, as it was hissing and spluttering.

While a new one was on order, I decided to chase the ABL circuit and see if there was anything untoward there. It turned out to be a fairly involved circuit but my hunch was correct in the end – several surface mount components on the A board, including Q312 (2SA1162-G), D315 (ISS3565) and D316 (a 6.8V zener diode), were faulty. This was rather surprising because I would have expected Q512 to have been destroyed as well but it was OK.

The new horizontal output transformer finally restored the set until the next onshore sea breeze. And the customer was happy.

The SAMPO chassis

The Philips Group has produced over 5000 different models of colour TV sets in the last 30 years. Almost all have been designed and made by the company but there are a few that have been made outside.

Two that come to mind are made in Taiwan – the SAMPO-1 and SAMPO-2 chassis (Models 26CE1991 and 28CE-1965). Anyway, Mr Tennant phoned for a home service call on his Philips set, a 28CE1965, complaining that when it was cold it was hard to start. And he was convinced that it was the on/off switch. Well, of course – if it isn't the fuse, the switch or the tube – it can't be anything else!

When I arrived, he had the set on and so it was switching on and off perfectly every time. I just couldn't accept that the switch was faulty only when it was cold, so I told him that I suspected the power supply and probably the electrolytic capacitors in it and that it would have to go to the workshop.

Back at the workshop with the back off, I could see the set was very well made and that it used a Toshiba IC chip set. There is no master power switch – the set is controlled by a subminiature push switch going to a microprocessor and then a relay.

I found and replaced capacitors C713, C714, C717, C735 in the power supply which were dried out. I then put it back into operation and left it to soak test on the bench but with back off just in case I had to do any further work. After a few days, it was still working correctly and so I put the back on.

However, with the back on, I found it difficult to turn the set off with the

remote control. I didn't discover this until it had run all day and it was time to turn it off, so I wondered whether this new problem might be caused by additional heat affecting something. I tried it for another day, before opening it again. And with the back off, I couldn't fault it, so I was even more suspicious of the heat factor and replaced even more capacitors – C740, C741, C744 & C745 – in the auxiliary power supply for the relay and microprocessor.

Well, I still couldn't fault it with the back off but once back in its case, the set intermittently wouldn't switch off with the remote control, even when it was cold. However, it did respond to the switch on the set.

Consistent with my old age, it took a while for the cause to sink in. The chassis slides in from the back, on plastic rails, until the escutcheon mounted pushbutton controls just touch the push switches. However, the combination of the chassis being pushed too far forward and a slightly distorted power knob meant that the microswitch was permanently switched on. So, when the remote control was used, it could only mute the sound but not turn the relay off. However, when the switch itself was pressed, it released itself properly.

So Mr Tennant was right; or at least partially – there was a problem with the switch assembly.

Another Philips

I had a Philips 28GR6775/75R G110-S chassis in for repair at about the same time. This model was very popular in Australia and there are a lot of them about.

Mr Brady brought this one in and, originally, it had intermittent vertical deflection and linearity but the fault was now permanent.

I replaced capacitors C2813 and C8214 (both 1500µF 40V electrolytics), which were leaking badly and thought that that would fix it. However, before replacing them, I had to clean off the excess electrolyte on the board. It had even leaked underneath the chassis but no visual damage to anything was apparent. Unfortunately, having done all this, the fault was still there.

I measured everything in sight with the ohmmeter but could find nothing wrong. I then spotted a surface mount component link (4815) under C2813 and C2814. This had 000 printed on it, denoting zero ohms, and connects C2813 and C2814 together.

Anyway, when I measured this, it did indeed measure zero ohms but when I hit it with freezer, while the set was on, the vertical timebase began to scan. I felt that it was telling lies and linked it out with a fair dinkum wire link. This fixed the fault completely and when I measured the surface-mount link again, I found it was high resistance.

I can only assume that the corrosion from the electrolyte had damaged it in a manner such that it failed under load.

Dark NEC

A Thai-built NEC portable 34cm remote control TV set was brought with a dull dark picture. It was an N-3452 model with PWT-101A chassis.

The voltage on TP91 was only 85V when on but shot up to 143V on standby. It should have been 116.5V so something was very wrong. The power supply uses an STK 730-80 (IC601) and I noticed that it raised the voltage when hit with freezer.

The voltage input across capacitor C604 was a very healthy 320V.

I then started looking for any electros in the primary or control section of the power supply and at first didn't see any. But then I spied C610 (10µF, 50V) on the circuit although I couldn't see it on the board. I finally found it tucked up tight behind IC601 and replaced it.

This was indeed lucky as it was the culprit and not the expensive IC I was about to order and replace.

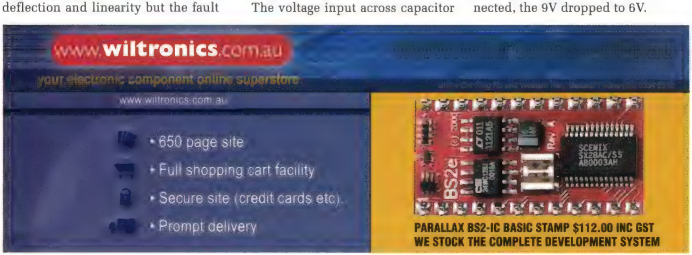
A crook guess

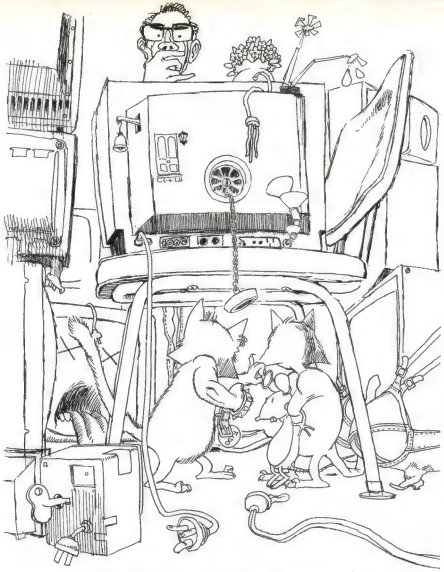
I don't appear to be very good at guessing which jobs look easy and which don't. Mrs Lyon's Sony KV-1415AS (SCC-F35A, G3E chassis) had a very small dark picture and for all the world it looked like the main HT was low, which would be relatively easy to repair.

However, after I had taken the back off, I measured the HT and it was spot on at 115V, on the cathode of D608. So my main theory was quickly dissolved.

I moved to my fall-back position – when in doubt, measure all the power rails. This I did, and realised fairly quickly that all the secondaries of the horizontal output transformer were low and the EHT was down to about 15kV. There are three main voltages from the transformer: 200V for the CRT video outputs, 26V for the vertical output and 15V for all the ancillary circuits. I started with the latter by disconnecting the output of IC851, a 9V IC regulator, to see if the rail would come up when the load was removed.

I was back on track again! Disconnecting the 9V rail brought all the secondaries up to normal – but what was loading it? There were no shorts on the 9V rail but when it was reconnected, the 9V dropped to 6V.





THIS WAS REALLY ONE OF THOSE SETS THAT WASN'T WORTH FIXING...

Unfortunately for me, the 9V rail goes everywhere in the set. So in the absence of any other brainwave, there was nothing for it but to progressively disconnect the devices being fed by the 9V rail and keep track of its value.

Much later, I found that desoldering the links to Q851 (2SA1162), a surface-mount PNP regulator, made a significant difference, even though the device itself was perfectly OK. I then found that disconnecting diode D251 (ISS119) in series with the collector of this transistor restored everything.

That surprised me, as both these devices are minute and yet were holding this rail down by one third! I measured D251 to find it too was perfect – so where to now? D251 fed the bases of the two transistors, Q251 and Q252, which apply audio muting to IC251 (the audio output IC).

Once again, I had to disconnect components to find out where the current was going. I desoldered Q251 and Q252 in turn but found that it was D250, another ISS119, that was causing the problem. It was leaky and replacing it fixed the set completely.

So what was the significance of D250? As already stated, its cathode (along with D251) fed the two muting transistors. The anode goes to the emitter of Q2004, which is in the power on/standby circuit and feeds horizontal drive transistor Q801 via R057 (1kΩ).

Not being a circuit designer, my hypothesis is that a leaky diode reduced the drive to the horizontal output stage. And it was this that was causing the low output rather than a current overload problem.

It was an interesting case but unfinancial as far as I was concerned. Mrs Lyons' set had been fixed at a significant discount but she still thought it was too expensive!

Panasonic VCR

With the low cost of VCRs, I am getting less and less to repair, the exception being the more expensive hifi and SVHS machines. Recently, I had a Panasonic NV-FS90A with no TV reception – the tape would play OK and all the other functions were fine.

Unlike most similarly dated SVHS machines from Panasonic, this model selected AV via the program selector in sequential order, or it could be selected on the remote control. Other models have a switch on the front panel offering Tuner, Simulcast or Auxiliary inputs.

This set was stuck in the AV mode and wouldn't switch to TV at all. I took a long time studying the service manual and in the course of tracing the circuit, discovered that C1003, the memory back-up capacitor, had leaked electrolyte onto the main board, corroding at least three tracks.

I thought that linking the broken tracks would fix the problem but it wasn't to be. The critical point was pin 4 of the microprocessor (IC6001, MN188166VDU) which should have 5V on it for the TV function.

It took a long time to realise that the corroded tracks were not the only problem. IC6001 itself was also faulty but only on pin 4. But why had such a complex microprocessor failed only on one pin. The reason, I suspect, was because the electrolyte from the leaking capacitor had shorted the nearby -20V to pin 4.

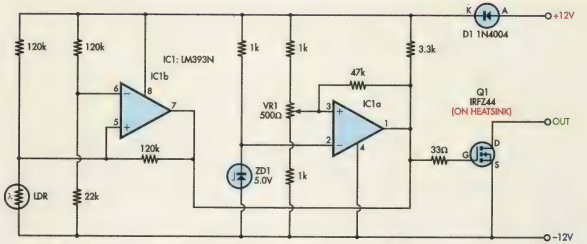
I worked out a fix by shorting Q607's base and collector, to hold this rail at 5V. But this fix was incomplete – it fixed the TV problem but only at the expense of the AV function.

Basically, of course, the answer was to replace IC6001. But I hesitated. It was a large and fairly expensive unit and, with labour costs, would make a costly exercise. And I sensed that the customer was worried about further costs. As an alternative, I suggested that I could fit a toggle switch so that he could switch between the AV and TV inputs. However, he ultimately decided that he really had no further use of the AV inputs and that a switch would look out of place.

So we left it at that. The customer was happy and I was happy. What more could one want? **SC**

CIRCUIT NOTEBOOK

Interesting circuit ideas which we have checked but not built and tested. Contributions from readers are welcome and will be paid for at standard rates.



Solar battery protector prevents excessive discharge

This circuit prevents the battery in a solar lighting system from being excessively discharged. It's for small systems with less than 100W of lighting, such as several fluorescent lights, although with a higher rated Mosfet at the output, it could switch larger loads.

The circuit has two comparators based on an LM393 dual op amp. One monitors the ambient light so that lamps cannot be turned on during the day. The second monitors the battery voltage, to prevent it from being excessively discharged.

IC1b monitors the ambient light by virtue of the light dependent resistor connected to its non-inverting input. When exposed to light, the resistance of the LDR is low and so the output at pin 7 is low.

IC1a monitors the battery voltage via a voltage divider connected to its non-inverting input. Its inverting input is connected to a reference voltage provided by ZD1. Trimpot VR1 is set so that when the battery is charged, the output at pin 1 is high and so Mosfet Q1 turns on to operate the lights.

The two comparator outputs are connected together in OR gate fashion, which is permissible because they are open-collector outputs. Therefore, if either comparator output is low (ie, the internal output transistor is on) then the Mosfet (Q1) is prevented from turning on.

In practice, VR1 would be set to turn off the Mosfet if the battery voltage falls below 12V.

The suggested LDR is a NORP12, a weather resistant type available from Farnell Electronic Components Pty Ltd.

Michael Moore,
Beecroft, NSW.

Radio controlled electronic flash

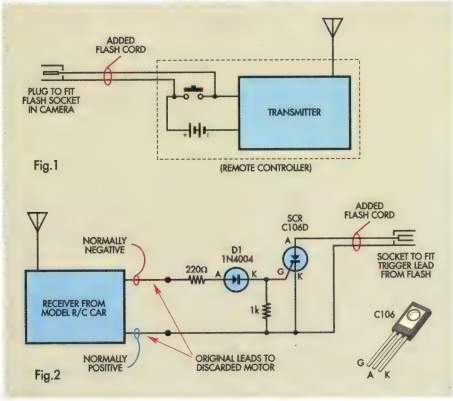
A radio controlled electronic flash is a useful item in any photographer's kit. Professionals use them all the time. For example, a wedding photographer would put one behind the bride to back-light her gown and veil. You don't want wires showing in a shot like that.

To build this control you will need an old R/C car (the simplest sort) in which the car runs in reverse at switch-on and goes ahead only when the remote is operated. They can be picked up cheaply as school fetes and garage sales. A typical car will run from 3V (two cells) and use 9V in the transmitter.

Before proceeding, make sure that the electronics in the car are operating. It doesn't matter if the wheels are broken or the motor is dead. You need to gain access to the leads to the motor. Normally (ie, without the remote operating), one is positive with respect to the other. Label them accordingly. On pressing the remote button, the polarity of the motor leads should swap.

You will also need a flash exten-

continued on page 46



Radio controlled electronic flash: continued from page 45

sion cord you can cut into two sections.

At the transmitter, the camera end of the extension cord is fed into the case and soldered to the control button contacts, as shown in Fig.1. The contacts are in series with the battery supply, so if you don't want to open the transmitter, just cut one of the battery leads and connect the flash extension cord into the gap so created.

You will then need to tape down the remote button so that it is permanently operated (ie, closed).

All that needs to be done at the receiver end is to connect the normally negative motor lead to the gate circuit of an SCR, as shown in Fig.2, while the normally positive lead goes to the cathode of the SCR. Now, when the transmitter is operated by the camera's contacts, the lead polarity is reversed and the SCR acts as a switch to fire a portable electronic flash via the other half of the flash extension cord.

The transmitter can be attached to the camera via a flash bracket or a screw into the tripod socket, depending on what is the most convenient arrangement.

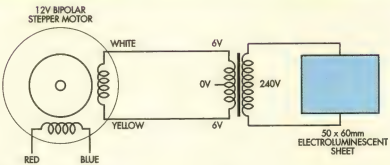
The added components in the receiver can be mounted on Veroboard and housed in the space where the electric motor was. If appearance is a primary consideration, the receiver and the added components could be mounted in a standard jiffy box.

Finally, a note of caution: when connecting the flash end half of the extension cord to the SCR, make sure that it is the positive wire which goes to the anode of the SCR. Flash cords do not always have the centre wire connected to the centre pin of the plug. The centre pin of the lead on the flash unit will be positive and this must connect to the anode of the SCR via the lead connected to the R/C receiver.

A. J. Lowe,
Bardon, Qld. ($40)

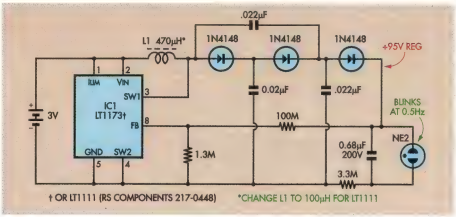
Luminescent generator

When spun rapidly between the fingers, a bipolar stepper motor will generate around 10VAC. If this is stepped up with a small 240V to 6-0-6V transformer in reverse (with series connected secondaries), a small bipolar stepper motor is capable of powering a standard 5cm by 6cm luminescent sheet at full brightness. These are designed to be powered from 20V to 200VAC (typically 115VAC), producing 1.5 candelas of light – which will dimly light the average room, or adequately light a camp table. They are manufactured by Seikosha (RS Components Cat. 267-8726).



The transformer should be a small one (around 100mA or so), otherwise efficiency is compromised. The wires of the motor's two phases are usually paired white & yellow and red & blue. Just one of these phases is employed in the circuit. If a small bipolar stepper motor from a discarded 3.5-inch disk drive is used, the Luminescent Generator may be built into a very small enclosure. To sustain rapid, smooth spinning of the motor, a geared handle may be added.

Thomas Scarborough,
Cape Town, SA. ($30)



Neon flasher runs from 3V supply

A neon indicator typically requires at least 70V to fire it and normally would not be contemplated in a battery circuit. However, this little switch-mode circuit from the Linear Technology website (www.linear-tech.com) steps up the 3V battery supply to around 95V or so, to drive a neon with ease.

The circuit has two parts: IC1 operating as step-up converter at around 75kHz and a diode pump, consisting of three 1N4148 diodes and associated .022µF capacitors. The 3.3MΩ resistor and the 0.68µF capacitor set the flashing rate to about once every two seconds.

The average DC level from the diode pump is set to about 95V by the 100MΩ feedback resistor to pin 8.

The circuit could also use an LT1111 (RS Components Cat 217-0448) which would run at about 20kHz so L1 could be reduced to 100µH and use a powdered iron toroid core from Neosid or Jaycar.

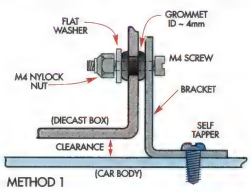
SILICON CHIP.

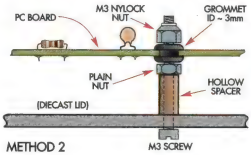
Isolation for PC boards in cars

These two mounting methods were devised to protect PC boards from vibration when installed in the engine compartment of a car. They could also be used in other applications where vibration is a problem.

Method 1 involves rigidly mounting the PC board inside a diecast box and then mounting the box itself to provide vibration isolation. As shown, small grommets are installed in suitably sized holes in the sides of the box. The box is then secured to angle mounting brackets using M4 screws, washers and nylock nuts.

Method 2 involves mounting the diecast case onto the chassis of the car and then mounting the PC board as shown, using M3 screws, grommets, hollow spacers and nylock nuts. In this case, the grommets are fitted into suitably sized holes in the PC board itself. Once the nuts are tightened, the PC board should be able to move slightly, relative to the box.

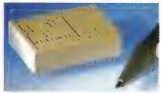




If there is not enough space on the board to fit the grommets, then Method 1 is the way to do it.

David Boyes, Gordon, ACT. ($35)

The Tiger comes to Australia

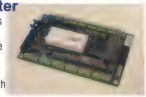


The BASIC, Tiny and Economy Tigers are sold in Australia by JED, with W98/NT software and local single board systems.

Tigers are modules running true compiled multi-tasking BASIC in a 16/32 bit core, with typically 512K bytes of FLASH (program and data) memory and 32/128/512 K bytes of RAM. The **Tiny Tiger** has four, 10 bit analog ins, lots of digital I/O, two UARTs, SPI, I²C, 1-wire, RTC and has low cost W98/NT compile, debug and download software.

JED makes four Australian boards with up to 64 screw-terminal I/O, more UARTs & LCD/keyboard support. See JED's www site for data.

TIG505 Single Board Computer



The TIG505 is an Australian SBC using the TCN1/4 or TCN4/4 Tiger processor with 512K FLASH and 128/512K RAM. It has 50 I/O lines, 2 RS232/485 ports, SPI, RTC, LCD, 4 ADC, 4 (opt.) DAC, and DataFLASH memory expansion. Various Xilinx FPGAs can add 3x 32bit quad shaft encoder, X10 or counter/timer functions. See www site for data.

$330 PC-PROM Programmer

This programmer plugs into a PC printer port and reads, writes and edits any 28 or 32-pin PROM. Comes with plug-pack, cable and software. **Also available is a multi-PROM UV eraser with timer, and a 32/32 PLCC converter.**

JED Microprocessors Pty Ltd
173 Boronia Rd, Boronia, Victoria, 3155
Ph. 03 9762 3588, Fax 03 9762 5499
www.jedmicro.com.au

MULTI-POWER

An easy-to-build bench power supply

This handy bench power supply has no expensive meters and offers six fixed dual-polarity supply voltages: ±3V, ±5V, ±6V, ±9V, ±12V and ±15V DC. And for added flexibility, you can use any of the first three outputs and any of the second three at the same time.

By JIM ROWE

FULLY VARIABLE DC bench supplies with voltage and current meters are great for checking circuits that operate from odd-ball voltages. They're also essential for checking the voltage range over which a circuit operates correctly. However, for a lot of work, they can represent overkill.

Some of the bells and whistles on a typical supply can even be a drawback, when you're simply trying out an idea for a circuit that must work from a bog-standard supply rail. For example, on many low-cost bench supplies, the meters are either too small or too inaccurate to allow you to properly check that the output is set within tolerance. So you generally have to reach for your DMM and check the voltages anyway, before even connecting the supply to your circuit.

There can also be a problem when it comes to trying out a circuit that needs multiple supply rails. Most bench supplies have two outputs at most and even these are generally balanced – ie, the positive and negative outputs closely track each other. That's great when you do want balanced supply rails but not so useful if you want say +12V and -5V. In that case, you generally need a second supply altogether.

In fact, if you need three rails – say +5V, -5V and +12V – there's usually no option but to use a second supply. And if you need a fourth rail, you might well have to use either a third supply or at the very least, two different balanced twin supplies.

All of which demonstrates the truth of that old saying in electronics: "you can never have too many power supplies!"

Multiple fixed outputs

For a lot of day-to-day bench work, what would be really handy is a small

supply with four outputs – especially if these outputs could be easily switched to select commonly used fixed voltages. Such a supply wouldn't need any voltmeters, because of the fixed outputs, and for a lot of work it wouldn't need current metering either. And none of the outputs would need to have a high current/power rating, since most bench work now involves very low power circuitry.

This line of thinking culminated in the compact, low-cost four-in-one bench supply described in the January 1998 issue of "Electronics Australia". It was a very handy little supply and quite popular too but it did turn out to have a few shortcomings. For example, it had a choice of only four output voltages: ±5V and ±12V. Obviously, there are situations where other voltages are required.

The other "shortcoming" was that it was not suitable for beginners, because of the transformer and mains wiring inside the case.

The idea behind this new design has been to come up with a supply that's not only more flexible than the 1998 version but easier and safer to build as well. It still offers only four output voltages at once (two bipolar pairs) but these can now each be switched between three pairs of voltages. You can have either ±3V, ±5V or ±6V from one set of outputs and either ±9V, ±12V or ±15V from the other set.

Despite this extra flexibility it's even easier to build than before, because all of the internal wiring is on two PC boards which connect directly together. There's really no off-board wiring at all.

There are no safety worries for beginners either, because the supply gets all its power at very low voltage from an external 9V/1A AC plugpack. The highest voltages anywhere inside the case are only 9VAC and 27V DC.

Like the earlier design though, it won't deliver really high currents. You can draw up to about 750mA at ±3V, 550mA at ±5V, 450mA at ±6V, 600mA at ±9V, 500mA at ±12V and 350mA at ±15V. This is for each output used singly of course but the figures don't "droop" too rapidly when multiple outputs are in use – the main limitation is the regulation of the AC plugpack.

Fig.1 shows the performance details in graphical form (see also the accompanying specifications panel).

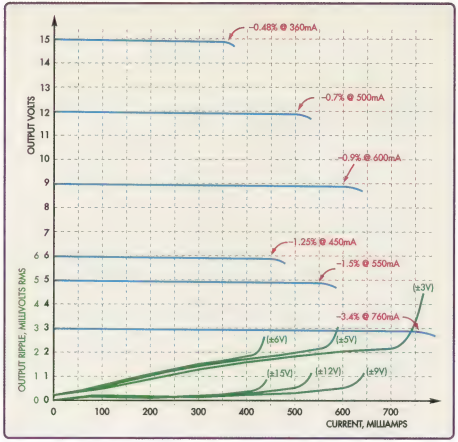


Fig.1: this graph shows the output current capabilities (blue) for the various fixed voltage outputs. The ripple performance is also plotted (green).

As you can see, it still has enough "grunt" for most experimental bench work. So although it deliberately lacks a lot of the traditional bells and whistles, it's still a surprisingly practical unit. The outputs are overload and short-circuit protected and the output terminals are spaced on standard 19mm centres to allow the use of dual banana plugs if desired.

The circuit

Refer now to Fig.2 for the circuit details. It may seem a bit daunting at first glance but it's really very straightforward.

First, there are four simple rectifier and filter circuits producing raw DC rails from the 9V AC delivered from the plugpack. Each rectifier then drives an adjustable 3-terminal regulator with a switch to select one of three regulated output voltages. It's mainly the plugpack which sets the unit's total power rating of around 9W (9V x 1A).

The two low-voltage rectifiers are standard half-wave circuits, each based on a single 1N5404 power diode (D1 & D2) feeding a pair of 2200µF filter capacitors. These rectifiers produce about ±13V of unregulated DC under no-load conditions, drooping

SPECIFICATIONS

Outputs: 2 x dual-polarity pairs (VA & VB) plus two common terminals.

Output Voltages: 3 x dual polarity low-voltage outputs (VA); 3 x dual-polarity high-voltage outputs (VB), as follows:

(1) Low-voltage switch (VA): ±3V @ 750mA; ±5V @ 550mA; & ±6V @ 450mA

(2) High-voltage switch (VB): ±9V @ 600mA; ±12V @ 500mA; & ±15V @ 350mA

Power supply: 9VAC 1A plugpack

Overload and power indication: 4 x 3mm LEDs

Load switching: independent toggle switches for each output pair

down to lower voltages as current is drawn. The 1N5404 diodes have a current rating of 3A continuous and 200A peak, so they should be virtually "unbreakable" here.

For the higher voltage outputs, we use half-wave voltage doubling rectifiers, each with a 2200µF series capacitor, a pair of 1N5404 power diodes (D3 & D4 and D5 & D6) and a pair of 1000µF filter capacitors. These rectifiers produce about ±27V of unregulated DC under no-load conditions, which again droops as current is drawn.

By the way, the relatively poor regulation of the half-wave rectifiers doesn't pose a problem. In fact, it helps keep the power dissipation of the regulators down to an acceptable level, by lowering the voltage across the regulators at higher load currents.

The maximum power dissipated by any of the regulators is 3.5W, which is reached by the high-voltage regulators when delivering ±9V at 400-450mA. This is acceptable because the regulators are all mounted on a reasonably good heatsink (the rear panel) and have inbuilt thermal overload protection anyway. If they do get too hot, they automatically shut down for a while to cool off.

As shown on Fig.2, the positive 3-terminal regulators are LM317T devices while the negative regulators are LM337Ts. Both of these regulator ICs are capable of handling up to 1.5A of current so, like the rectifier diodes, they're being used quite conservatively here.

The regulator circuits all use virtually the same configuration. This is because the LM317 and LM337 regulators work in the same way, acting to maintain a fixed voltage across the resistor connected between their "output" and "adjust' terminals (240Ω for the positive regulators and 120Ω for the negative regulators).

In each case, the regulator keeps the voltage across these resistors fixed at 1.25V.

Because virtually all of the current through these resistors comes from the output terminal and almost no current flows in or out of the adjust terminal, virtually the same current flows in any resistance we connect between the adjust terminal and ground. So we are able to set the actual output voltage of the regulator by adjusting this lower resistance value, to set up a "bootstrap" voltage drop that's equal to the desired output voltage less the 1.25V that's maintained across the upper resistor.

For example, in the low-voltage positive regulator (REG1), the series 470Ω and 430Ω resistors give a total of 900Ω, which produces +4.75V between the adjust pin and ground. As a result, the regulator's output is +6.0V (4.75 + 1.25) when these resistors are in circuit alone. Similarly, for REG2, the 1.5kΩ and 1.1kΩ resistors alone give an output of +15V, while the 270Ω and 180Ω resistors in the REG3 circuit give an output of -6V, and so on.

To set the two lower output voltages for each regulator, we simply switch in additional shunt resistors across these lower resistors, to reduce their value and hence the voltage drop.

For example, in the REG1 circuit, we switch in a 3.3kΩ resistor to lower the regulator's output voltage to +5V, or the parallel 2.2kΩ and 680Ω resistors to bring it down to +3V. Exactly the same arrangement is used for the other three regulators.

Note that the two low-voltage regulator outputs (REG1 & REG3) are set using switches S3a & S3b, while the high-voltage regulator outputs (REG2 & REG4) are set using S4a & S4b – ie, each pair of outputs is tied together. As a result, S3 and S4 are respectively marked "VA SELECT" and "VB SELECT" on the front panel, to ensure easy operation.

In addition, load switches S1a & S1b allow you to switch the two low voltage outputs together, while S2a & S2b perform the same role for the two high-voltage outputs. These switches are miniature toggle types and are positioned quite close to each other on the front panel. So with a little dexterity, it's quite easy to switch all four outputs on or off within a few milliseconds of each other.

As shown in Fig.2, each regulator has a 100µF filter capacitor across its output and a 10µF capacitor from its adjust pin to ground to provide additional filtering. There are also reverse-biased diodes connected between each regulator's output and input (D7, D9, D11 & D13) and between the output and adjust terminals (D8, D10, D12 & D14).

Fig.2 (facing page): the circuit uses four simple rectifier and filter circuits to produce raw DC rails from the 9V AC delivered from the plugpack. Each rectifier then drives an adjustable 3-terminal regulator to derive the fixed output voltages.

Parts List

1 plastic instrument case, 155 x 160 x 64mm, with metal rear panel (2mm thick aluminium)
2 PC boards, code 04104021 (119 x 124mm) and code 04104022 (134 x 48mm)
6 banana jack screw terminals (2 red, 2 black, 2 green)
2 DPDT miniature toggle switches (S1, S2)
2 2-pole, 3-position rotary switches (S3, S4)
1 DC power socket, 2.6mm (PC-mount)
1 9V 1A AC plugpack
23 PC terminal pins, 1mm diameter round type
4 TO-220 insulating kits
4 M3 x 12mm round head machine screws
4 M3 nuts, flat washers and star lockwashers
2 instrument knobs, 19mm dia.

Semiconductors

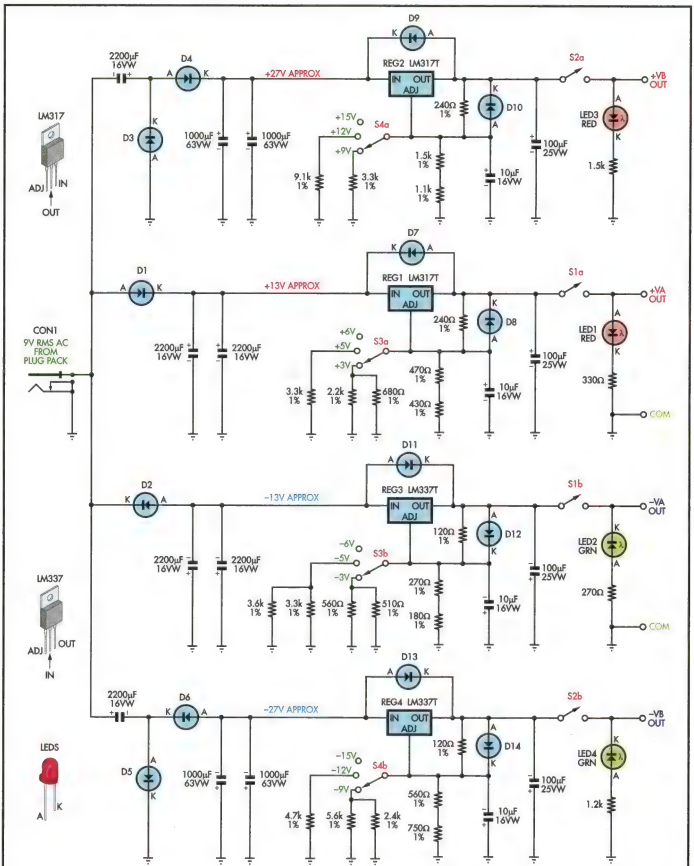
2 LM317T 3-terminal regulators (REG1, REG2)
2 LM337T 3-terminal regulators (REG3, REG4)
6 1N5404 3A power diodes (D1-D6)
8 1N4004 1A power diodes (D7-D14)
2 3mm red LEDs (LEDs 1 & 3)
2 3mm green LEDs (LEDs 2 & 4)

Capacitors

6 2200µF 16VW RB electrolytic
4 1000µF 63VW RB electrolytic
4 100µF 25VW RB electrolytic
4 10µF 16VW RB electrolytic

Resistors (0.25W, 1%)

1 9.1kΩ	1 680Ω
1 5.6kΩ	2 560Ω
1 4.7kΩ	1 510Ω
1 3.6kΩ	1 470Ω
3 3.3kΩ	1 430Ω
1 2.4kΩ	1 330Ω
1 2.2kΩ	2 270Ω
2 1.5kΩ	2 240Ω
1 1.2kΩ	1 180Ω
1 1.1kΩ	2 120Ω
1 750Ω	



MULTI-POWER BENCH SUPPLY

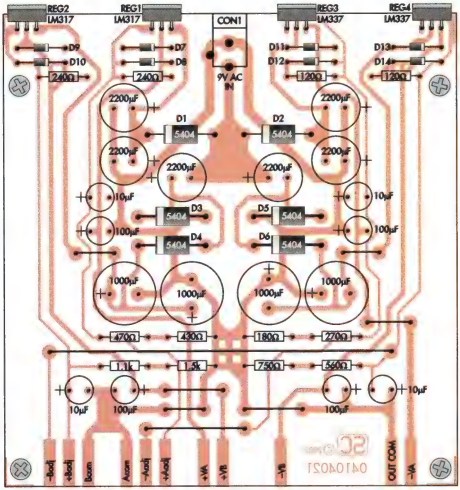


Fig.3: install the parts on the main PC board as shown in this diagram. Note, however, that REG1-REG4 are not installed directly on the board – instead, you have to install PC stakes at each of their lead positions and the regulators are then later soldered to these stakes (after mounting them on the rear panel).

The "upper" diodes are included to protect the regulators against damage if the outputs are accidentally connected to a voltage higher than that across their input filter capacitors. This can happen, for example, if you turn off the power to the supply's plugpack and then suddenly turn on one of the two load switches, thus connecting its regulator outputs to charged bypass capacitors in an external circuit.

The "lower" diodes similarly protect the regulators from damage due to any charge remaining in the 10µF filter capacitors when the AC input power is removed.

To save costs and keep the circuitry as simple as possible, there's no current monitoring or limiting, apart from that provided inside the regulator chips themselves. However, each of the four outputs has a simple LED status indicator, based on LEDs 1-4 and their series resistors. This means that should one of the regulators begin to shut down in response to an overload, that output's LED will become dim – so you'll at least be warned of an overload situation. That's the cue to hit the appropriate switch and investigate the cause of the overload!

This simple system works quite well in practice, despite its low cost.

Construction

The complete supply is housed in a standard plastic instrument case measuring 160 x 155 x 65mm. Inside the case, everything is mounted on two compact PC boards which solder together at right angles: a main board which is mounted horizontally in the lower half of the case and a switch/output terminal board which mounts vertically behind the front panel.

The main board is coded 04104021 (119 x 124mm) and carries all the components used in the rectifiers. The four 3-terminal regulators also mount along its rear edge, so they can be bolted to the rear panel which acts as the heatsink (the usual plastic rear panel is replaced by a 2mm-thick aluminium plate). Also on this board are the basic components used in each regulator circuit and the power supply AC input connector (CON1).

The vertical PC board is coded 04104022) (134 x 48mm) and supports mainly the front-panel components: ie, voltage selector switches S3 & S4, load switches S1 & S2, the six output terminals and the four indicator LEDs. Also on this board are the LED series resistors and the voltage selection resistors switched into the regulator circuits by S3 & S4.

The connections between the two boards are made via 11 PC terminal pins, which solder to circular pads near the bottom of the vertical board

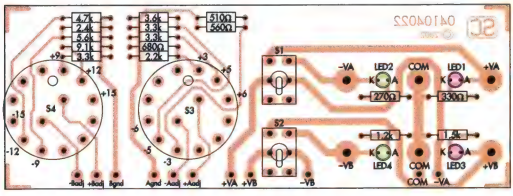
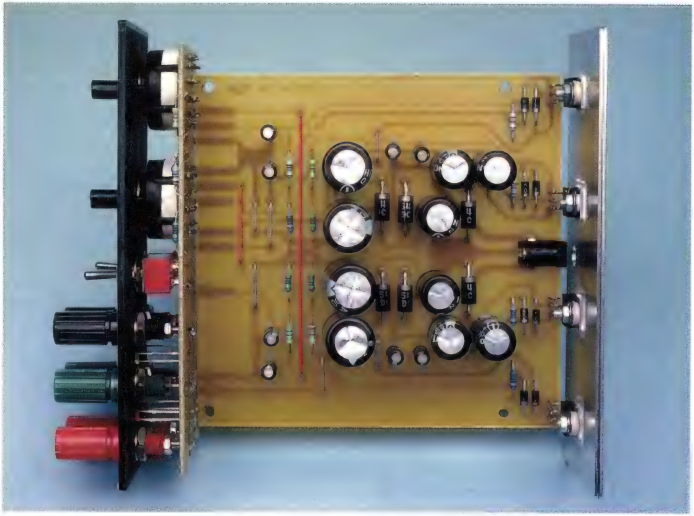


Fig.4: this is the parts layout for the vertical PC board. Refer to the text for the details on mounting rotary switches S3 & S4. Eleven PC stakes have to be soldered to the otherwise vacant pads along the bottom of the board. These are installed from the copper side and connect to matching pads on the main PC board (see Fig.5).



Here's what the completed assembly looks like before it's installed in the case. We sandwiched two 1mm-thick aluminium panels together to make up the rear-panel heatsink but you can use a single 2mm-thick panel.

and to rectangular pads along the front edge of the main board. As well as making the connections, these pins also hold the two boards together at 90°.

Putting it together

Assembling the supply is easy, particularly if you tackle it in the following order.

First, inspect both PC boards and make sure they've been trimmed to the correct sizes and that there are no solder bridges between tracks. This done, begin the main board assembly (Fig.3) by fitting three PC terminal pins to each regulator position along the rear edge – ie, 12 pins in all.

Next, fit the 2.6mm power connector CON1 to the board, followed by the eight wire links. Note that most of the links can be made using bare tinned copper wire (eg, component lead offcuts) but the two longest links should be made using insulated hookup wire.

With the links in place, you can then fit the resistors, 1N4004 diodes and finally the larger 1N5404 power diodes. Make sure the diodes are all fitted with the correct polarity, as shown in the overlay diagram, and be sure to fit the correct diode in each location.

Once the diodes are fitted you can fit the electrolytic capacitors, again taking care with their polarity. Your main board should then be complete and you can put it aside while you work on the second board.

Begin the assembly of this board (Fig.4) by checking that the holes have been drilled to the correct sizes to accept the larger items, such as the rear of the output terminals and the rotary switch connection lugs. That done, fit all of the resistors, again using the overlay diagram as a guide.

The only other items to fit to the board at this stage are the two rotary switches but first you have to trim their control shafts to about 10mm from the threaded mounting ferrule. That done, rotate each switch shaft fully anticlockwise, remove its locking nut and star washer, and move the indexing collar three positions anticlockwise. Finally, replace the star washers and mounting nuts to lock the collars down.

Each switch should now operate over three positions (instead of six).

You might also want to file a "flat" on each switch shaft (if one isn't already present), to help prevent the knobs from working loose later. The flat should be diametrically opposite the switch locating spigot, when the rotor is in its centre position

After the shafts have been trimmed and given flats, both switches can be fitted to the board, with their locating spigots directly above the shafts (see Fig.4). You may need to straighten their lugs a little, to allow them to mate with all of the board holes cor-

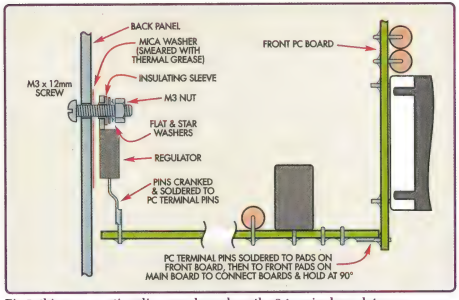


Fig.5: this cross-section diagram shows how the 3-terminal regulators are attached to the rear panel (using TO-220 insulating kits) and their leads bent so that they can be soldered to the matching PC stakes on the PC board. The diagram also shows how the two PC boards are connected together.

rectly. That done, solder all the lugs to the board's copper pads, with the switch body in contact with the front of the board.

The next step is to fit the four LEDs in their correct positions, as shown in Fig.4. Just tack-solder one lead of each LED at this stage and DON'T cut any of their leads short – they're just being positioned for final mounting later. Take care to ensure that the LEDs are correctly oriented – the anode lead is the longer of the two (see Fig.2).

Before you can proceed any further with this board, you have to prepare the front panel (that's because they combine to form an integrated assembly). So the next step is to drill and/or ream the holes in the front panel, using a copy of the artwork as a template. It's also a good idea to file the holes for the output terminals with "flats" on each side as suggested by the artwork, to prevent them rotating and working loose later.

You may also want to provide small "blind" holes above the main mounting holes for switches S3 and S4, to accept the switch locating spigots.

Check also that the holes for the 3mm LEDs will in fact accept the LED bodies without too much force. The ideal hole size is where the LED will just fit snugly, without being loose.

The adhesive label can now be attached to the front panel and the holes cut out using a sharp utility knife. This done, mount the toggle switches and output terminals. The switches should be fitted with the nuts adjusted so that the switch bodies are reasonably close to the panel, with the threaded ferrules protruding 1.5mm or so beyond the front nuts (this is to facilitate board mounting later on). The green terminals are fitted in the two centre "Common" positions, with the black terminals for the negative outputs and the red terminals for the positive outputs.

If your toggle switches are fitted with standard "solder lug" terminals instead of PC terminals pins, now is the time to fit short lengths (say 20mm) of tinned copper wire to the top four

Table 1: Resistor Colour Codes

No.	Value	4-Band Code (1%)	5-Band Code (1%)
1	9.1kΩ	white brown red brown	white brown black brown brown
1	5.6kΩ	green blue red brown	green blue black brown brown
1	4.7kΩ	yellow violet red brown	yellow violet black brown brown
1	3.6kΩ	orange blue red brown	orange blue black brown brown
3	3.3kΩ	orange orange red brown	orange orange black brown brown
1	2.4kΩ	red yellow red brown	red yellow black brown brown
1	2.2kΩ	red red red brown	red red black brown brown
2	1.5kΩ	brown green red brown	brown green black brown brown
1	1.2kΩ	brown red red brown	brown red black brown brown
1	1.1kΩ	brown brown red brown	brown brown black brown brown
1	750Ω	violet green brown brown	violet green black black brown
1	680Ω	blue grey brown brown	blue grey black black brown
2	560Ω	green blue brown brown	green blue black black brown
1	510Ω	green brown brown brown	green brown black black brown
1	470Ω	yellow violet brown brown	yellow violet black black brown
1	430Ω	yellow orange brown brown	yellow orange black black brown
1	330Ω	orange orange brown brown	orange orange black black brown
2	270Ω	red violet brown brown	red violet black black brown
2	240Ω	red yellow brown brown	red yellow black black brown
1	180Ω	brown grey brown brown	brown grey black black brown
2	120Ω	brown red brown brown	brown red black black brown

This close-up view of the rear panel shows how the four 3-terminal regulators are mounted. Note that the regulators must all be electrically isolated from the rear panel using TO-220 insulating kits (see Fig.5). They are connected into circuit by soldering their leads to matching PC stakes on the main PC board.

lugs of each, pointing directly backwards along the lug axis but with a small loop around the side of each lug before soldering – to make sure it can't drop off when you later solder it to the PC board pad.

You should now be ready to mate the front panel and the vertical PC board together. This involves pushing the rotary switch shafts and their threaded ferrules through the front panel holes (you have to remove the locking nuts first) and at the same time pushing the rear spigots of the output terminals and the leads on the rear of the toggle switches through the corresponding holes in the board. It's a bit fiddly but not too difficult if you take it carefully.

Once the two are mated together, you may need to adjust the positions of the mounting nuts and washers for the toggle switches so that the switch positions fore-and-aft will allow both panel and board to be truly parallel to each other, with a space of very close to 16.5mm between them everywhere. Tighten the toggle switch nuts at this point, followed by the rotary switch nuts – but carefully, so you don't strip the plastic threads or slip and scratch the front panel.

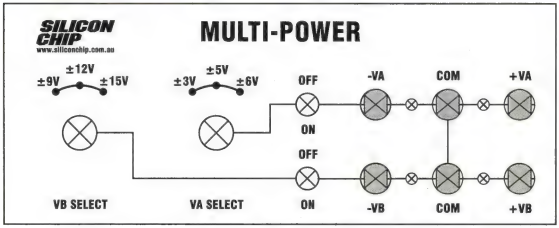
You should now be able to solder the ends of the output terminal spigots to their large pads on the PC board. The toggle switch leads can then also be soldered to their respective pads.

That done, you can untack each LED from its initial position and carefully push it forward until its body fits snugly in the corresponding front panel hole. Its leads can then be soldered properly to the board pads and any excess finally trimmed off.

The next step in preparing this board/panel assembly is to lay it face down on the bench and fit the 11 PC terminal pins which will connect it to the main board. These are all fitted from the copper side, so their main length protrudes backwards from the board. Solder each one carefully to its pad.

The two boards can now be mated

The rear panel is pretty uninspiring – just the four screws that secure the regulators plus a hole for the power socket.



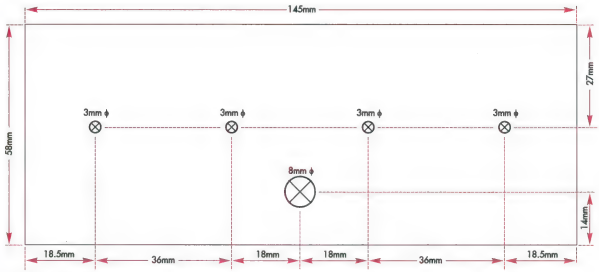


Fig.6: these full-size artworks can be used a templates for drilling the front and rear panels. Note that the holes for the for the banana jack terminals have straight sides, so profile these carefully.

together, by soldering these same 11 terminal pins to the rectangular pads along the front of the horizontal board. This is best done with the main board upside down (ie, copper side up) and with the other board/panel assembly also upside down but held at right angles using a small strip of 18 x 32mm wood or similar as a guide.

It's a good idea to just tack solder the pins at each end first and then make sure everything is aligned properly in terms of both the 90° angle and the side-to-side positioning. Once all is well, you can then solder all the pins to their pads to complete the assembly.

At this point, you can fit the control knobs to the rotary switch shafts, ready to adjust the output voltages. The module is now essentially finished (apart from the regulators which are fitted during the final assembly) and can be put aside while you prepare the rear panel.

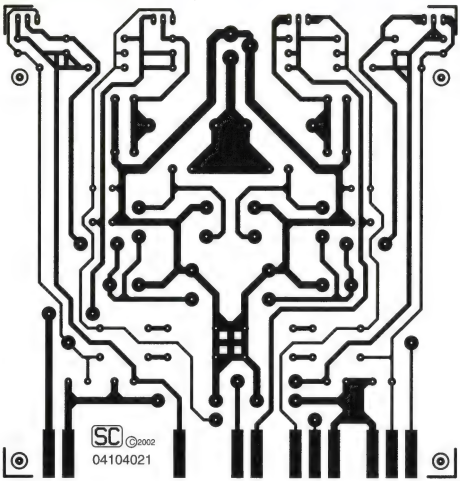
Rear panel work

In order to provide reasonable heatsinking for the four regulators, the rear panel should ideally be made from 2mm-thick aluminium sheet. I didn't have this available so I used two 1mm-thick pieces in "parallel".

There are only five holes to drill/ream in the rear panel – 4 x 3mm-diameter holes for the regulator mounting screws and 1 x 8mm-diameter hole to clear the power input socket. Their positions are shown in Fig.6, so there shouldn't be any problems with them. Just make sure you don't leave any burrs around the 3mm holes in particular. A countersink bit or a large drill bit can be used to remove any metal swarf and make the edges smooth.

With the rear panel drilled, the next step is to crank the three leads of each regulator IC forward, so that they end up immediately behind the terminal pins on the rear of the main PC board after final assembly. This is done by gripping each regulator's leads with a pair of needlenose pliers about 4mm from the body (just after the leads narrow) and then bending all three upwards at 45°. The pliers are then used to grip them a further 5mm along, after which they are bent back down again by 45° (see Fig.5).

The four regulators can now be fitted to the rear panel but first make sure that all the mounting holes are smooth and free of metal swarf. Fig.5 shows the mounting details. Note that each regulator must be electrically isolated from the rear panel using insulating bushes and mica washers. Smear all mating surfaces with silicone grease



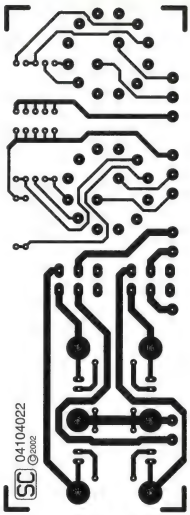


Fig.7: these are the full-size etching patterns for the two PC boards. Check your etched boards carefully for any defects before installing the parts.

before bolting the regulators down.

Alternatively, you can use silicone-impregnated thermal washers instead of the mica washers, in which case you don't need the thermal grease.

Make sure that you mount each regulator in the correct location – the two LM317Ts mount on the lefthand side of Fig.3, while the LM337Ts are on the right-hand side.

When you have fitted them all, it's a good idea to check with a DMM or ohmmeter to ensure that there's no connection between any of the regulator leads and the panel. If you do find a short between any of the leads and the rear panel, remove the regulator and locate the source of the problem before refitting it.

Final assembly

The next step is to fit the board and front panel module into the lower half of the case. You do that by sliding the ends of the front panel carefully down into the front case slot. This should allow the main board to sit flat on the case support spigots, with the mounting holes located over the centre hole in each spigot.

If the alignment isn't quite right, you may need to remove the board assembly again so that you can enlarge one or two of the board holes in the required direction. That done, refit the board assembly and install four 6mm x M3 self-tappers to hold it in position.

The rear panel (and its 3-terminal regulators) can now be installed in the rear case slot. This should position each set of cranked regulator leads behind their corresponding PC terminal pins (in fact, they should be just touching).

Check that all the leads are correctly aligned before soldering them to their respective PC pins.

Checkout time

If you've followed these instructions carefully, your supply should work correctly as soon as you plug the lead from the 9V AC plugpack into CON1.

Each of the two pairs of LEDs should glow as soon as you switch on each pair of supply outputs using the two toggle switches. You can then check each of the output voltage pairs using your DMM. Check that you get the correct readings for each position of the two rotary switches – all voltages should be within about ±1% of their nominal values, under no load conditions.

About the only possibilities for error are fitting the electrolytic capacitors or diodes incorrectly to the main PC board; mounting the regulators in the wrong positions on the rear panel; mixing up some of the resistors on the vertical PC board, or fitting one or more of the LEDs the wrong way around. So if your supply doesn't work properly, check these possibilities first after quickly switching off.

And that's it – you've just finished making yourself a very handy little four-in-one bench supply. All that should remain is fitting the top of the case and putting it to use! **SC**

More FAQs On The MP3 Jukebox

The MP3 Jukebox player featured in the September & October 2001 issues continues to be a popular project and hundreds have been built. Since we published the FAQs in this project in the January 2002 issue, more questions have arisen. Here are the answers to some of them.

Using A Bigger LCD

Q Great project. The MP3 player is just what I have been looking for since I set up my dedicated MP-3 machine about 10 months ago. I have been using an LCD driver I downloaded from the net, which is working well, but having a full keyboard around has been a nuisance. So the remote control will be well received around the family!

What I would like to know is can the software be easily adapted for a 4-line by 20-column display? I have considered having a go myself but my programming experience is limited to VBA (Excel) and I have no experience with microcontrollers so why not ask the experts!

Rob Walls,
via email.

A The IR Remote software could be modified without too much trouble to work with a 20x4 display. All fields of the ID3v1 tag are read and stored and available for use by the LCD output routines. You will need a copy of VB6 Pro (or know someone that does) in order to modify/recompile the code, though. As mentioned in the January 2002 edition (page 21), you can download the source code from the SILICON CHIP website.

The microcontroller code would also be quite easy to modify for the larger display size but you will need to know your way around the Atmel AVR chips.

Sorry, but we can't give you actual examples of how to do this right here – we would have to spend quite a bit of time making the changes and testing them and as you can imagine, we're hard at work on projects for upcoming issues!

Download Failed On Remote Interface

Q I just recently constructed an MP3 Remote Interface kit which I purchased from Altronics. When the hardware was completed, I went to your website to download all the appropriate software (IRRLCD.ZIP) + (IRR10.EXE). After the download, I went to the Hyperterminal as instructed and attempted to download the new file IRREE.EEP. The file was sent to the Interface and a second or so later, a message "Download failed!" appeared on the LCD panel.

Can you help? I tried to download the software again with no results and tried using other clone PCs. Apart from that, I noticed that the remote control couldn't control many functions; eg, forward track or shut-down but I believe that this was a result of the download failure.

Kwan Lee, via email.

A It's unclear from your message why you have tried to reprogram the microcontroller's EEPROM.

As detailed in the article, this step is only required if you wish to change a number of default start-up parameters (which are documented in IRREE.ASM). In order to modify these parameters, you will need at least a basic familiarity with the internal workings of the Atmel 90S series microcontrollers.

The microcontroller you received with your kit should already have both the program (FLASH) and data (EEPROM) memory pre-programmed. This means that you do not have to reprogram it unless you wish to make changes as indicated above.

Assuming that you really do want to reprogram the EEPROM, then the first step is to make sure that everything is working correctly before making any changes.

The "Download failed" problem you

IRR10.EXE Won't Minimise

Q I know you don't offer support on the software at your site but just a quick question you might be able to help me with: the MP3 jukebox kit software IRR10.exe doesn't seem to minimise once initialised. It says READY, READY then just stays on the desktop without minimising to system tray. I can't see the system tray icon at all. I've tried reinstalling it three times. I'm using a freshly installed Windows Milllenium computer. Any help would be appreciated.

Clinton C, via email.

A IR Remote won't minimise to the system tray if any kind of problem occurs during initialisation. You'll need to scroll up in the list of messages in the little status window in order to determine where the problem lies.

Problems With Winamp

Q I recently purchased the MP3 JukeBox kit from Altronics, as detailed in your September and October 2001 issues. I put the kit together and got everything working. Then I downloaded the plugin for Winamp and was less then impressed.

I think a more elaborate plugin is needed or an alternative one. Although it seems to work, what is needed is support for a large playlist to just run normally with the remote control support. None of this metalist nonsense.

The Plugin works fine but the thing that ruins it is its inability to play random. I tried several playlist files of varying sizes. Also I tried a metalist following strictly the instructions given but instead of detailing the whole playlist in the Winamp playlist window I notice it only displays the current song being played. This also makes this song play over and over again, unless I press next song on my remote control.

I have the exact universal remote control detailed in the instructions (AIFA AV8E). I am really anxious to resolve my Winamp plugin problems and use my jukebox. I originally intended to purchase one device, get it up and running then purchase several more but this great device is being held back by a heavily limited plugin for Winamp.

G. Bulloch, via email.

A Firstly, we should mention that the IRRemote software was not designed as a true Winamp plugin and was not presented as such in the magazine. The intention is to control Winamp without the graphical interface, which is why the playlist does not appear in Winamp's window.

We put a lot of work into the metalist implementation, so we obviously don't think it is nonsense. As it is, a single playlist supports up to 199 tracks, which in our opinion isn't too shabby anyway.

We've had no other reports of the random (shuffle) play function not working. As detailed in the article, when you've enabled shuffle play, a small "S" symbol should appear on the LCD. Note that it's important that you do not also click on the "Shuffle" button in the Winamp window, as this function is designed to be controlled by IRRemote.

describe below could be caused by a number of factors. First, verify that the port settings in Hyperterminal are correct (see the September 2001 issue, page 31) and that characters you type in appear correctly on the LCD as detailed in the article.

Next, when attempting to download the EEPROM file, make sure to select "Send Text File" (not "Send File") in Hyperterminal.

If the above doesn't help, then suspect a problem with hardware handshaking. This could be caused by a wiring error – check that the "READY" signal from the IR Receiver & LCD Module goes to pin 8 of the female D-9 connector.

The remote control should be able to control all functions mentioned in the magazine article, assuming you have successfully assigned each function to a key (see October 2001, page 30). The contents of the EEPROM do not affect the operation of the remote control.

MP3 power supply

Q You have the MP3 Jukebox powered from a 12V rail but you are using only a 5V regulated supply. Is there any obscure reason why I should not run it from the 5V computer supply and leave the 7805 regulator out?

I have had a look through the code for the microcontroller. You have done an excellent job.

Brian Stephenson, via email.

A The MP3 player is powered via a regulator instead of the PC's +5V rail for three reasons. First, it allows those using it in a remote housing to power it from a plugpack. Secondly, it eliminates the problem that can occur with the LCD module's viewing angle varying as a result of slight variations in power supply voltage. Finally, it allowed us to fit a series polarity protection diode!

There's no reason why you can't run it without the diode and regulator but leave the filter capacitors in place.

Winamp Playlist Not Displayed

Q I'm having trouble with my MP3 Jukebox. I have a Duron 750 with 768MB RAM, 20GB hard disk, running Windows 98 and Winamp 2.75. The problem is that the irremote program loads the playlist but only loads the first song and not the others.

I only have 40 songs in the playlist and the playlist is in the same directory as my MP3. If I add songs after the playlist loads, the title info stays on the display but the song length changes. Can help me with this problem?

Warren Anderson, via email.

A Only one track is ever displayed in Winamp's playlist – the track currently loaded by IR Remote (and displayed on the LCD). This is as we intended - remember, the Jukebox software was designed to be used without the Windows graphical interface.

However, you should be able to move to any track in your playlist using your remote and the instructions detailed in the article. If not, then examine the information displayed in IR Remote's status window (use the up arrow to scroll back) for possible problems loading/scanning the playlist file.

It's not possible to manually add tracks to Winamp's list while IR Remote is running. It is also important not to click on the "Shuffle" or "Repeat" buttons in Winamp, as this will confuse IR Remote.

Possible Atmel Chip Substitution

Q I'd like to build the MP3 player which uses an Atmel AT90S2313 chip for my PC. My question is, can I use an AT89*2051** chip instead with a 12MHz crystal? The pinouts are almost identical.

Michael Girton, via email.

A You must use the AT90S2313-4 (or AT90S2313-10) with a 4MHz crystal as specified. Although it's not obvious from the pinouts, the AT89 chips are entirely different internally.

Based on an Atmel microcontroller, this incredibly versatile timer is suitable for a wide range of applications. It's built on a compact PC board and both the trigger input and the output are fully isolated so that you can trigger from and/or switch high voltages.

Multi-Mode Timer

By FRANK CRIVELLI & PETER CROWCROFT

EVERYONE WHO BECOMES involved with electronics builds a timer at one stage or another. There are thousands of designs using a variety of circuits, some of which have been around for decades. Witness the 555 timer IC, for example. This is one of the longest surviving ICs, being introduced about 30 years ago.

In the past, most timers were quite specialised in that they only performed one function – eg, an egg timer, a delayed timer, a timeout timer, a flasher, or a photographic timer, etc. Those days are now well and truly over – microcontroller ICs now allow us to easily design multi-purpose timers that can perform a variety of tasks, all at very low cost.

And that's exactly what you get with this new "Multi-Mode Timer". It supports no less than seven different timing modes using two ICs and a handful of other parts.

The various timing modes and delay ranges are selected using on-board DIP switches. You simply select the time delay you want and that's it – no further adjustments are required.

An optocoupler is used for the trigger input and this allows for complete electrical isolation between the trigger source and the remainder of the timer circuitry. This is important when high voltages are to be used for triggering the timer. An on-board relay provides electrical isolation of the output as well.

Triggering options

A number of triggering options are available, ranging from simple manual pushbutton triggering to electrically isolated voltage triggering. We'll take a closer look at the various triggering options that can be used later in this article.

As shown in the photos, all the parts are mounted on a single PC board, so it's really easy to build. Power supply requirements are quite modest and almost any 9-12V DC power source can be used. A 12VDC plugpack supply rated at 300mA will do the job quite nicely.

Timer modes

OK, let's take a look at the various timing modes that are available from this circuit. There are currently seven timer modes defined – mode 8 is unused at present. If there's another timer variation you would like (or even a completely different set of timing modes), then let us know. After all, it's only a software change!

The various modes are as follows:

Mode 1 – Instant On, Delayed Off, Level Triggered: a trigger signal operates the relay and starts the timing cycle. The relay then remains on for the selected delay time and then releases. A loss of the trigger signal also immediately ends the timing cycle and turns the relay off. The timer will then be ready for another trigger signal.

Mode 2 – Instant On, Delayed Off, Edge Triggered: this is the same as Mode 1 except that loss of the trigger signal does not effect the timing cycle.

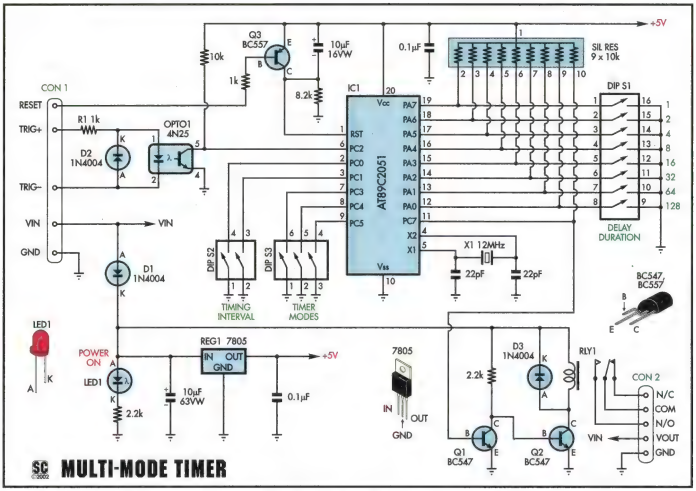


Fig.1: the circuit for the Multi-Mode Timer is based on IC1, an Atmel 89C2051 microcontroller. This is preprogrammed with software to provide all the timing modes, which are set using DIP switch DIP3 (see Table 1). Triggering is via optocoupler OPTO1, while relay RLY1 isolates the timer's output.

However, applying another trigger signal before the end of the timing cycle will restart the timer from zero. The effect is a "re-triggerable" timer.

Mode 3 – Delayed On: a trigger signal starts the timing cycle. At the end of the delay time the relay operates and remains on until the trigger signal is removed or the timer is reset. Loss of the trigger signal during the delay time aborts the timing cycle.

Mode 4 – Instant On and Hold, Delayed Off: a trigger signal turns on the relay but does not start the timing cycle. The relay then remains on while ever the trigger signal is present. Loss of the trigger signal then starts the timing cycle and the relay turns off at end of delay time.

Mode 5 – Toggling: a trigger signal turns on the relay for the selected delay time. The relay then switches off for the same period. This cycle continues until loss of trigger signal or until a reset signal is applied.

Mode 6 – Instant On, Delayed Off, With Pause: similar to Mode 1, a trigger signal operates the relay and starts the timing cycle. However, loss of trigger signal causes the timing cycle to pause and the relay remains on. Reapplying the trigger signal then restarts the delay time from the point where it was interrupted. At the end of the delay time, the relay turns off.

Mode 7 – Delayed On with Pause: a trigger signal starts the timing cycle. At the end of the delay time the relay operates for 2 seconds and the timing cycle starts again. Loss of trigger signal causes the timing cycle to pause. Reapplying the trigger signal restarts the timing cycle from where it was stopped. Reset is the only way to exit this mode.

Mode 8 – Not used.

Important: note that for each of the

SPECIFICATIONS

Operating Voltage	12VDC (see text)
Trigger Voltage	6-81V DC (see text)
Trigger Current	5mA minimum; 80mA maximum (see text)
Trigger Pulse Width	20ms minimum
Relay Contact Rating*	10A @ 240V AC max.
Timing Modes	8 (see text)
Timing Ranges	1-255s, 10-2550s, 1-255 minutes, 10-2550 minutes

NB: although the relay contacts are rated at 240VAC, the relay should be limited to switching voltages up to about 40-50V DC or AC. DO NOT use the on-board relay to switch 240VAC (mains) voltages (see text).

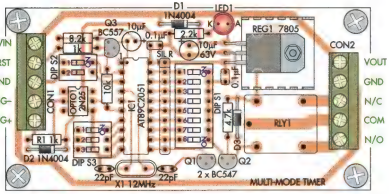


Fig.2: install the parts on the PC board in the order listed in the text but don't install IC1 into its socket until the test procedure has been completed. A small mini-U heatsink is required for REG1.

timer modes, a reset signal will stop the timing cycle immediately and reset the timer, ready for another trigger signal. The timer is reset by connecting the RST input to the GND input — see Fig.1.

Circuit details

Refer now to Fig.1 for the complete circuit details. At the heart of the circuit is IC1, an Atmel 89C2051 microcontroller. This is preprogrammed with software to provide all the timing functions.

A 12MHz crystal between pins 4 & 5 provides accurate timing and an easily divisible clock source for the internal hardware timers. Crystals are generally accurate to ±100ppm (parts per million) so, in this case, the actual crystal frequency could vary by as much as 1200Hz either side of 12MHz – an error of .01% maximum.

Over a period of 42.5 hours (2550 minutes, the maximum delay time this unit can be programmed for), this amounts to a maximum error of just ±15.3s.

The trigger signal is applied to the input of OPTO1, a 4N25 optocoupler. As previously mentioned, using an optocoupler allows the trigger signal to be electrically isolated from the timer circuit. This is especially useful if triggering the unit from high voltages. Diode D2 protects the optocoupler's input from damage due to reverse voltages, while the 1kΩ resistor provides current limiting.

Normally, the optocoupler output is high (ie, at 5V) and goes low (to 0V) when triggered. In this case, the load resistor is 10kΩ, which means that we need a current of 0.5mA through it for the output of the optocoupler to go to 0V.

From the 4N25's data sheet, the input current required is 10 times the output current. This means that we need a minimum input current of 5mA to trigger the timer.

The voltage across the optocoupler's internal LED, Vf, is typically 1V and remains fairly constant regardless of input current. Therefore, the minimum input voltage necessary to trigger the timer is given by:

Vin = (Iin x R1) + Vf
= (5mA x 1kΩ) + 1V = 6V

If lower trigger voltages are required, then it's necessary to reduce the value of R1.

The maximum optocoupler input current is 80mA, which means that the maximum trigger voltage is (80mA x 1kΩ) + 1V = 81V. Of course you should allow for a safety margin of say 5-10mA. If higher trigger voltages are to be used, you will need to either increase R1 or add an external resistor.

The output from the optocoupler is used to trigger the microcontroller, IC1. This works in conjunction with its internal software program and DIP switches DIP1-DIP3 which are connected to ports A & C of IC1. The internal software reads the DIP switch settings and sets the timing mode and duration accordingly.

IC1's output appears at pin11 and drives transistors Q1 and Q2, which in turn operate the relay. So why are two transistors used here instead of just one? It's all to do with what happens on reset.

On reset, the microcontroller's I/O ports are configured as inputs (via internal hardware) and "float" high. If only one transistor was used, the relay would be activated during reset. Of course, the relay would be released after reset once the onboard software took over but that's not what we want.

By using two transistors, we can use a low output to operate the relay and a high to release it. And that means that the relay doesn't turn on during reset!

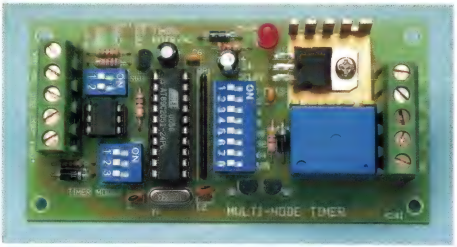
Power supply

The timer requires a nominal 12VDC power supply; eg, a plugpack supply or a 12V battery. The incoming voltage is fed to REG1, a 7805 3-terminal regulator, to derive a regulated +5V rail which is then used to power IC1 & IC2. Diode D1 protects against reverse polarity connection of the power supply, while LED1 provides power-on indication.

Note, however, that the relay requires a 12V supply and so it is connected directly to the VIN supply input, rather than to the 5V rail (as is transistor Q1). This also minimises any switching noise on the +5V supply rail to IC1 when the relay turns on and off. Diode D3 is there to prevent

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (5%)	5-Band Code (1%)
❑	1	10kΩ	brown black orange gold	brown black black red brown
❑	1	8.2kΩ	grey red red gold	grey red black brown brown
❑	1	4.7kΩ	yellow violet red gold	yellow violet black brown brown
❑	1	2.2kΩ	red red red gold	red red black brown brown
❑	2	1kΩ	brown black red gold	brown black black brown brown



This slightly larger-than-life view shows just how compact this versatile timer really is. A 9-12VDC plugpack supply rated at 300mA can be used to power the unit.

back EMF from damaging Q2 when the relay releases.

Power on reset is provided by R2 and C3 (the 89C2051 microcontroller has an active high reset signal). In addition, transistor Q3 allows the user to use a low-going signal to reset the timer; eg, by connecting the RESET terminal on connector X1 to the GND terminal via a simple pushbutton switch.

Putting it together

It's a cinch to put together – all you have to do is solder all the parts to the PC board as shown in Fig.2.

Install the resistors and diodes first, then install LED1, transistors Q1-Q3 and the electrolytic capacitors. Make sure that all the polarised parts are oriented correctly and double-check that Q3 is the BC557.

Take particular care when installing the SIL resistor pack (RP1). Pin 1 is identified by a dot at one end of its body and this goes towards the adjacent 0.1µF capacitor.

The DIP switches and relay RLY1 can go in next, followed by the 3-terminal regulator (REG1). The latter is mounted flat against the PC board together with a small U-shaped heatsink. That means that you have to bend REG1's leads down at right angles before fitting it to the board.

The best way to do that is to loosely attach the regulator to the board using a 3mm machine screw and then grip its three leads with needle-nose pliers. The screw can then be removed, the regulator lifted clear and its leads bent down through 90°. That done, REG1 and its heatsink can be fastened

Parts List

1 PC board, code K141
1 12MHz crystal (X1)
1 12V relay, RWH-SH-112D (RLY1)
2 3-way PC-mount screw terminal blocks (5mm pitch)
2 2-way PC-mount screw terminal blocks (5mm pitch)
1 8-way DIP switch (DIP1)
1 2-way DIP switch (DIP2)
1 3-way DIP switch DIP3)
1 6-pin IC socket
1 20-pin IC socket
1 3mm x 8mm-long machine screw
1 3mm nut

Semiconductors
1 4N25 optocoupler (IC1)
1 AT89C2051 programmed Atmel microcontroller (IC2)
3 1N4004 diodes (D1,D2,D3)
2 BC547 NPN transistors (Q1,Q2)
1 BC557 PNP transistor (Q3)
1 7805 3-terminal regulator (REG1)
1 5mm red LED (LED1)

Capacitors
1 10µF 63VW PC electrolytic
1 10µF 16VW electrolytic
2 0.1µF MKT
2 22pF ceramic

Resistors (0.25W, 5%)
1 10kΩ
1 8.2kΩ
1 4.7kΩ
1 2.2kΩ
1 1kΩ
1 9 x 10kΩ 10-pin SIL resistor network (RP1)

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Keypad with serial interface
1 Megabit Memory Module
Low cost I/O Expander chips
A/D and eeprom chips
Real time clock kits
RC servo and stepper chips
Custom chips ...
Tech-Tools PIC Tools new
PIC emulators
Eeprom/Ram chip emulators
New PIC Quickwriter programmer
TiePie "Most" all in one
Multimeter
Oscilloscope
Spectrum analyzer
Transient recorder
HP2 & HS801
plus arb function gen in HS801-AWG
ron@nollet.com.au
R.T.Nollet
35 Woolart street
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ph/fax 03-9338-3306

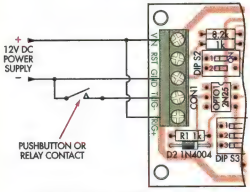

Fig.3: using a pushbutton or relay contacts to trigger the timer.

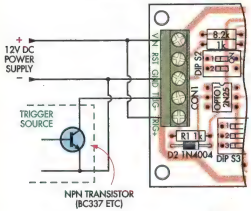

Fig.4: triggering the timer using the open collector output of an NPN transistor.

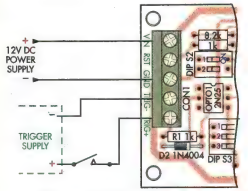

Fig.5: use this circuit for fully-isolated triggering. Note that the trigger source must not connect to the timer's power supply if you want complete isolation.

to the PC board using a machine screw and nut and the leads soldered.

Make sure that the heatsink is correctly aligned before tightening the screw, so that is doesn't foul the relay.

Now for the two 5-way screw terminal blocks. These are made by fitting together a 2-way block and 3-way block – just slide the raised edge on the side of one block into the matching groove of the other block. Each 5-way block is then installed on the PC board with the wire entry points facing outwards.

Don't install the ICs yet – that step comes later, after some initial tests. Just install their sockets for the time being, making sure that the notched end of each socket is positioned as shown on Fig.2.

Testing

Apply power to the board – the RED power LED should be come on and the relay should remain off. Now use a multimeter to check the voltage between pins 20 & 10 of IC1's socket – you should get a reading of 5V. If this checks out, connect a short length of wire between pins 10 & 11. The relay should immediately operate.

If all is well, remove power and install the ICs in their sockets. Make sure that both ICs are correctly oriented and that none of their pins are "bent under" as you insert them.

Setting the timer mode

The timer mode is set using DIP switch DIP3, as shown in Table 1. You will have to carefully read the details for the various timing modes at the start of this article before making your selection.

Note that mode 8 is unused, as mentioned previously.

Setting the delay

DIP switches DIP2 & DIP1 together set the time delay. DIP2 set the base timing interval, while DIP1 sets the multiplier (ie, Delay Time = base timing interval x multiplier).

TABLE 1: MODE SELECTION

Mode	DIP3-1	DIP3-2	DIP3-3
1	On	Off	Off
2	Off	On	Off
3	On	On	Off
4	Off	Off	On
5	On	Off	On
6	Off	On	On
7	On	On	On
8	Off	Off	Off

Table 1: the timing mode required is selected using DIP switch DIP3. Note that mode 8 is not used.

Tables 2 & 3 shows the possible settings for these two DIP switches.

An example will illustrate how this all works. Let's say that DIP1-8, DIP1-3 & DIP1-2 are ON and that the rest of DIP1's switches are off. In this case, the multiplier is 128 + 4 +2 = 134.

This means that the Delay time will be 134 x base timing interval. So if the base timing interval is 10 seconds, for example, the Delay Time is 134 x 10 seconds = 1340 seconds, or 22 minutes 20 seconds.

If DIP1-7 is also turned ON, then this adds 64 to the delay factor making it 134 + 64, or 198. The maximum delay factor is with all switches ON; ie, 255.

Setting all the DIP1 switches to the OFF position is invalid and the timer will not function.

Note that there is some overlap between the timing intervals. For example, you can get a 10-minute delay by selecting a 1-minute timing interval and setting the delay factor to 10 or by selecting a 10-minute timing interval and setting the delay factor to 1.

In summary, here are the time delays possible:

- 1 - 255s in 1s steps;
- 10 - 2550 seconds (42min 30sec) in 10s steps;
- 1- 255 minutes in 1- minute steps;
- 10 - 2550 minutes (42hr 30min) in 10-minute steps.

The timing accuracy for all modes is .01%.

Triggering the timer

As discussed earlier, the input trigger voltage needs to be in the range of

WHERE TO BUY A KIT

Kits for the "K141 Multi-Mode Timer" are available from Ozitronics (**www.ozitronics.com**) for $36.85 (incl. postage & GST). Phone (03) 9434 3806.

You can email the authors at **peter@kitsrus.com** if you have any suggestions. Information on other kits in the range is available from **http://kitsrus.com**

If you have any technical problems or questions, you can contact the kit developer at **frank@ozitronics.com**

Note: copyright of the PC board and the source code for the Atmel microcontroller is retained by the author.

TABLE 2: BASE TIMING INTERVAL		
Interval	DIP2-1	DIP2-2
1 second	On	Off
10 seconds	Off	On
1 minute	On	On
10 minutes	Off	Off

Table 2 (left): DIP switch DIP2 sets the "base timing interval". This value is multiplied by the "multiplier" (set by DIP1 – see Table 3) to give the Delay Time for the timer.

TABLE 3: INTERVAL MULTIPLIER								
DIP1	8	7	6	5	4	3	2	1
Value	128	64	32	16	8	4	2	1

Table 3: DIP switch DIP1 sets the interval multiplier. Note that if more than one switch is set to ON, the multiplier values are added together; eg, if DIP1-8, DIP1-3 & DIP1-2 are ON, the multiplier is 128 + 4 +2 = 134.

6-81V, although this can be varied by changing the value of R1 (see earlier text). Just how the trigger voltage is applied will depend on your application and the trigger source available.

Figs.3-5 show the triggering options available.

Probably the most common device used for triggering the timer will be a simple "make" contact, either from a pushbutton switch or relay contacts. Fig.3 shows the idea.

All you have to do is connect the TRIG+ terminal to the VIN terminal and connect the switch or relay contacts between the TRIG- and GND terminals. When the contact closes, the circuit path is complete and current flows, thus triggering the timer.

Fig.4 shows how to trigger the timer using the open collector output of an NPN transistor (this can either be a discrete transistor or incorporated into an IC package). Basically, the transistor takes the place of the switch shown in Fig.4. When the transistor turns on, the TRIG- input is pulled low and the timer triggers, as before.

Note that you can connect multiple open collector outputs in parallel, together with a common pull-up resistor; eg, if you want to trigger the timer from more than one source. That way, one or more of the open collector outputs can go low without causing damage to the others.

In both the previous two triggering methods, the trigger source ground is connected to the timer ground. This is often referred to as "commoning" and is done to provide a common reference point between the two circuits. However, this bypasses the electrical isolation on the timer's input because one side of the optocoupler's input is now connected to ground.

Fig.5 shows the circuit to use if you want complete electrical isolation. Note that, to ensure isolation, the trigger source must drive the input without any connection to the timer's power supply.

Relay outputs

The relay's NO, NC & C (normally open, normally closed & common) contacts are brought out to CON2 and can be used to switch external loads or other relays. In addition, VOUT and GND are provided as convenient connection points for powering external devices.

The relay outputs can be used to switch voltages up to about 40-50V. **However, don't try to use the relay outputs to switch 240VAC mains voltages – that would be much too dangerous, especially given the proximity of the ground track to the relay outputs.**

If you do want to switch mains voltages, you can use the on-board relay to switch an external relay that's adequately rated for the job. **Don't do this unless you are experienced know exactly what you are doing – mains voltages can be lethal!**

Troubleshooting

Poor soldering ("dry joints") is the most common reason for the circuit not working. If you strike problems, the first thing to do is to check all soldered joints carefully under a good light and resolder any that look suspicious.

You should also carefully check that the parts are in their correct positions and that all parts are correctly oriented. Check also to ensure that the ICs have been correctly installed and that none of the pins have been bent under their bodies.

Finally, check that REG1's output is at 5V. If there is no voltage at the output of this regulator, check the voltage at its input.

If there's no voltage here, then it's possible that D1 has been installed the wrong way around – either that or you've inadvertently reversed the supply leads. **SC**

ALTRONICS

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Last month we celebrated the release of our 19th Edition Engineering Catalogue and I must say the response has been outstanding. Here is a typical response ...

Jack Gilheaney, Managing Director

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G. Nolan - North Sydney NSW

• Full colour 272 pages • Over 500 new products • New easy to use format • Improved specifications • Revised data section

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C 9250 ONLY **$289**

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Stop fumbling around your lounge room and combine your VCR, DVD, VCD, CD player & your TV remote controls into one convenient master control.

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(SC Nov-Dec '01)

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(EA Nov '97)

This project identifies open or short wires in an instant and can eliminate the guess work when installing two or three way cables.It is an ideal complement to any audiophile or installers tool box.

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(SC June/July '01)

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K1672 RRP $229 Now **$179**

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(See SC Sept. '98)

This project provides stereo equalisation for tape/phono & mic, plus basic mixing functions, not normally included in the software.

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Features: Line output: 2V p-p RMS @ 1kHz • Full RIAA eq. 35dB gain @ 1kHz, input impedance 50k • Selectable gain of either 60dB or 50dB to suit mic. output • Flat response within 2dB from 35Hz - 18kHz, input impedance 100k • Tape/line ,mic. level, bass & treble controls, providing 12dB boost or cut @ 50Hz and 15kHz. • Attractive sloping case

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(See SC Oct/Nov '96) This multimedia kit is just the thing for incredible dynamic realism when playing your favourite games or listening to music on your CD-ROM.

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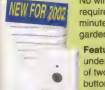

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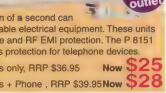

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NEW FOR 2002

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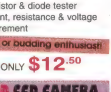

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(SC 'Jan 2002) Replace that old fashioned light dimmer with a modern looking touch plate dimmer.

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(SC 'Feb 2002)
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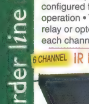

K 5600 **$249**

FREE! An A1013 remote control with every K 5600, valued at $36.00.

(SC 'Mar/April 2002) Use one IR remote control to simultaneously adjust the volume of up to 6 channels. Perfect for Dolby 5.1 channel, active speaker & DIY surround sound systems.

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Perfect for the K 5140 70W amp module

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These 4Ω coaxial speakers are perfect for use in a portable speaker system such as a guitar amplifier, portable PA or similar

NEW

Features: 50W RMS, 100W max power • 4Ω impedance • 92dB @ 1W/1m • 40Hz resonant frequency • 40Hz - 20kHz freq. response

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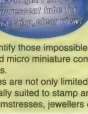

These polypropylene cone woofers make ideal replacement drivers to rejuvenate your old floor standing speakers. Alternatively combine them with an amplifier module and create a thumping active subwoofer for your home theatre system.

Save up to 35%

8" Driver features: 60W RMS power, 100W max • Frequency Response 34Hz-4kHz • Suggested enclosure 30L • Sensitivity 92dB 1W @1m

10" Driver features: 60W RMS power, 100W max • Frequency Response 28Hz-4kHz • Suggested enclosure 22L • Sensitivity 92dB 1W @1m

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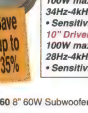

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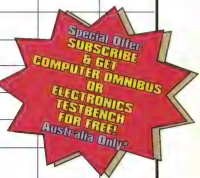

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03-01

Pt.2: Final Assembly & Testing

Just about any IR remote control that's capable of outputting Philips codes can be used. This is the Select 1 from Jaycar.

6-Channel IR Remote Volume Control

Last month, we gave the circuit details for our new 6-Channel Remote Volume Control and showed you how to build the PC board assemblies. This month, we complete the construction and give the test and setup details

By JOHN CLARKE

NOW THAT ALL THE PC boards have been built, it's time to prepare the metalwork. Hopefully, this unit will be made available as a complete kit, in which case the metalwork will be supplied predrilled.

Alternatively, if you're buying the bits separately, you will have to drill the case yourself.

As supplied, the case comes in pieces and it's a good idea to drill the front and rear panels before putting it together. The front and rear panel artworks (Fig.12) and the main wiring diagram (Fig.10) show the positions of these holes.

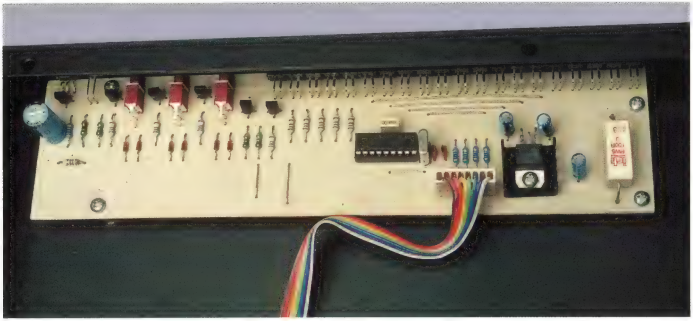
Starting with the front panel, you have to drill holes for mains switch S1, the 20-LED display, the three pushbutton switches, the acknowledge LED and the infrared receiver. The rectangular cutouts for the mains switch and LED bargraph can be made by first drilling a series of small holes around the inside perimeter of the cutout, then knocking out the centre piece and filing to the correct shape.

Don't make cutout for the mains switch too big – it must be a tight fit so that it is properly secured by its retaining tabs. The pushbutton switch holes should be about 9mm to allow clearance for the 7.5mm diameter switch caps.

The rear panel requires holes for the RCA sockets, the safety fuseholder, the mains lead cordgrip grommet and the earth terminal adjacent to the RCA sockets. Take care with the hole for the cordgrip grommet. This hole is not round – instead, it must be carefully profiled to match the shape of the grommet, so that the grommet can not later be pulled out when the mains cord is fitted.

The holes for the RCA sockets must be large enough to prevent the RCA plugs from making contact with the metal chassis when they are connected.

Once these holes have been drilled, assemble the case without the lid, using the machine screws supplied. The next bit is important: **be sure to scrape away the paint at the countersunk screw points, so that each section of the case makes good metal-to-metal contact. This ensures that each sec-**



This close-up view shows the mounting details for the Control & Display board. It mounts at the front of the chassis on four tapped 12mm spacers and is secured using eight M3 x 6mm screws.

tion is properly earthed to mains earth (important for safety reasons) and also prevents hum problems.

Next, mark out the mounting holes for the three PC boards on the baseplate and drill these holes to 3mm. You will also have to drill mounting holes for the earth lug, the mains terminal block screws and the transformer bolt (see Fig.10). Deburr all holes using an oversize drill.

Next, scrape away the paint or anodising from the area around the two earth lug mounting holes. This is necessary to ensure that the earth lugs make good contact with the bare metal of the case and is also an important safety measure in the case of the mains earth lug.

For the same reason, scrape away the paint or anodising from the bottom outside of the chassis around the mounting holes for the mains terminal block. This will ensure that the mounting screws are properly earthed.

Installing the hardware

The various hardware items – including the power transformer, switch S1, the fuseholder, the mains terminal block, the earth lugs and the PC boards – can now be installed in the case. The boards are installed as follows:

(1) Signal board: this mounts on two 6mm-long untapped spacers at the front and is secured using two M3 x 12mm screws and two M3 nuts and star washers. The RCA sockets are then secured to the rear panel using 6g self-tapping screws into the plastic mouldings.

The Signal Board is secured by attaching it to two 6mm-long untapped spacers along the front edge and by fastening the RCA socket assemblies to the rear panel using 6g self-tapping screws into the plastic mouldings.

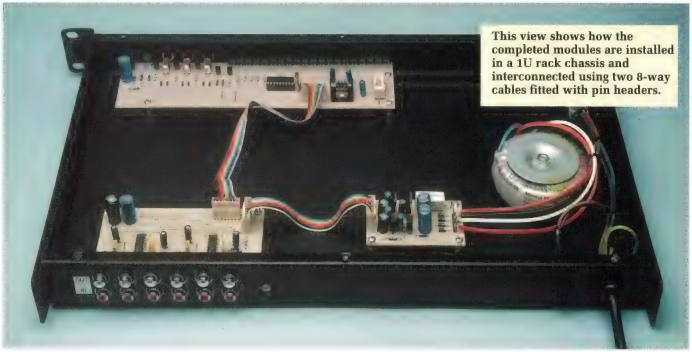
(2) Display board: this mounts on four tapped 12mm spacers and is secured using eight M3 x 6mm screws;

(3) Power supply board: this mounts on four 10mm M3 tapped spacers and is secured using eight M3 x 6mm screws.

The toroidal transformer is secured using the supplied bolt, rubber washers, metal mounting plate and nut. The rubber washers are placed between the transformer and chassis and between the transformer and the metal mounting plate. The assembly is then secured using the mounting bolt.

Do the bolt up firmly but don't overtighten it – you'll distort the chassis if you do.

The mains terminal block is secured to the chassis using two 12mm x M3 screws and nuts. Note that a piece of Elephantide insulation material measuring 35mm x 35mm is mounted un-



This view shows how the completed modules are installed in a 1U rack chassis and interconnected using two 8-way cables fitted with pin headers.

der-the terminal block as an additional safety measure.

Make sure that the mains earth lug is properly secured – it must be attached using an M3 x 10mm-long screw, nut and two star washers as shown in Fig.11. A second lock nut is fitted to this assembly, so that it cannot possibly come loose later on.

Now use your multimeter to confirm that there is zero ohms resistance between the earth lug and all the panels of the case. You should also get zero ohms resistance between the earth lug and the two mains terminal block mounting screws.

Before installing the mains wiring, it's necessary to check that the power switch is the right way up. To do this, switch it to the ON position and use a multimeter to check that the resistance between the two contacts is 0Ω. If the rocker needs to be in the OFF (up) position to get a 0Ω reading, the switch will have to be inverted.

Mains wiring

Fig.10 shows the mains wiring details. Exercise extreme caution when installing this wiring and be sure to follow Fig.10 exactly – your safety depends on it.

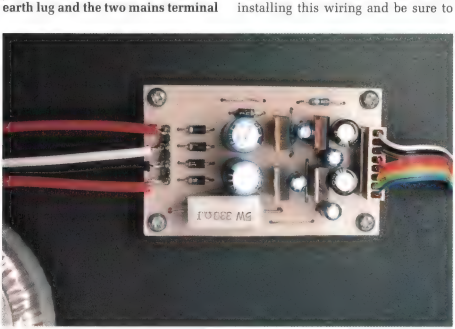
First, strip back about 350mm from the outer sheath of the mains cord, so that the Active (brown) lead has sufficient length to reach both the fuseholder and the power switch (S1). This done, clamp the mains cord into position using the cordgrip grommet. Check that the grommet properly clamps the cord to the chassis; you must NOT be able to pull the cord back out.

Next, trim the Active (brown) lead so that it is about 70mm long. The Active lead then goes to the centre terminal of the fuseholder, while the leftover brown lead is run between the outside terminal and the mains terminal block. Slip a 40mm length of 10mm-diameter heatshrink tubing over the two leads before soldering them to the fuseholder.

Once the connections have been made, push the tubing over the body of the fuseholder (so that the terminals are covered) and shrink it down using a hot-air gun.

The Neutral (blue) lead from the mains cord goes directly to the mains terminal block, while the Earth (green/yellow) lead is connected directly to the main earth lug. The Earth lead should be left long enough so that it will be the last connection to break if the mains cord is "reefed" out.

Now set your multimeter to low ohms range and check the resistance



The Power Supply board mounts on four 10mm M3 tapped spacers and is secured using eight M3 x 6mm screws.

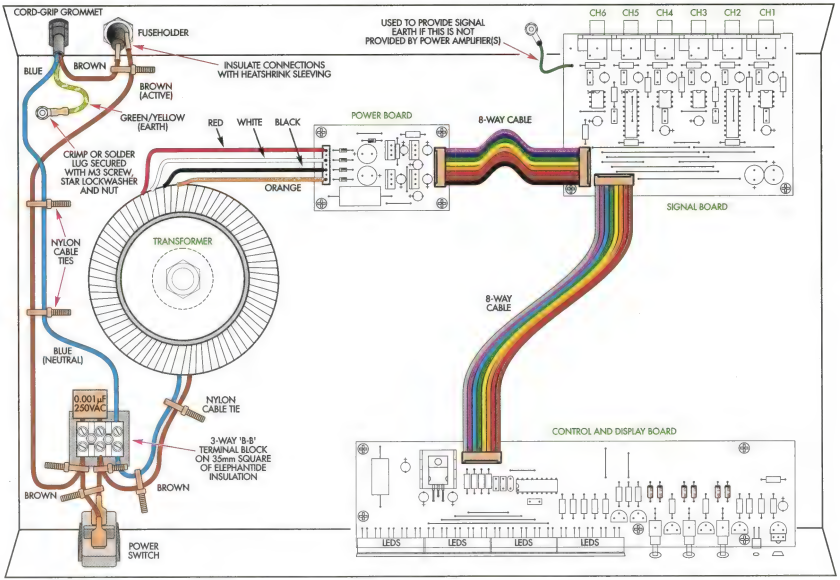
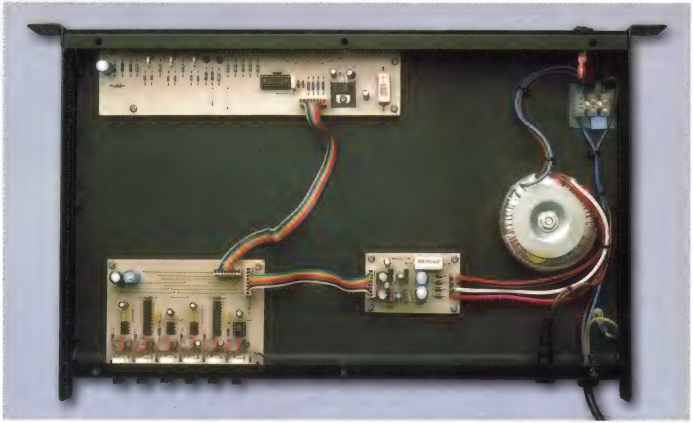


Fig.10: here's how to install the modules in the chassis and complete the wiring. Take great care with the mains wiring and be sure to insulate the exposed terminals on the fuseholder with heatshrink tubing as described in the text. The mains wiring should also be secured using cable ties as shown, so that the leads cannot possibly come adrift.



Another view inside the completed unit. Use cable ties to secure the mains wiring, so that the leads cannot possibly come adrift (see also Fig.10).

between the earth pin on the mains plug and the various chassis panels. In each case, you should get a reading of close to zero ohms.

Next, the .001µF capacitor can be installed and the transformer and mains switch wiring completed at the terminal block. In each case, make sure that the wire insulation goes into the mouth of the terminal block and is pushed all the way up to the brass connector before doing up the screw. Leads that share a common connection should be twisted together and lightly tinned with solder before inserting them into the terminal block.

Don't use a terminal block that's too small to accept the insulation from two leads – you must be able to push the insulation of both leads fully into the terminal block and all the way up to the brass connector.

The connections to the mains switch are made using fully-insulated female spade terminals. Make sure that the spade terminals are securely crimped to their leads before fitting them to the switch – a ratchet-driven crimping tool should be used for this job.

Finally, connect the transformer secondary leads to the Power Supply PC board as shown in Fig.10.

Use cable ties to lace the mains wiring together. In particular, you should install one tie close to the mains switch, another close to the fuseholder and several more close to the mains terminal block. This will prevent the leads from coming adrift and if one does come loose, it will be held in place so that the exposed end cannot move and make contact with the case. Any remaining cable ties can be used to secure the transformer's secondary leads.

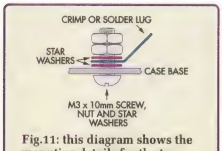


Fig.11: this diagram shows the mounting details for the two earth lugs. The second nut locks the first nut, so that there is no possibility of the earth lug later working its way loose. Don't forget to scrape away the paint or anodising from the area around the two earth lug mounting holes, to ensure proper contact with the chassis.

Completing the wiring

You now need to make up two 8-way leads with pin header sockets at each end to interconnect the three PC boards.

Begin by cutting a 110mm length of 8-way rainbow cable from the 270mm length supplied. That done, strip the wire ends, crimp them into the header pins and insert the pins into the header sockets (note: the header sockets must be oriented as shown in Fig.10). Now repeat this procedure for the remaining 160mm length of 8-way cable.

Connect the finished cables to the Signal and Display Boards but leave the Power Supply Board disconnected at this stage. You have to make sure that the supply board is delivering the correct voltages before making this connection.

Switching on

Before switching on, check the mains wiring carefully to make sure there are no mistakes. Check also that the wiring to the power supply board is correct.

Once you're sure that everything is correct, install a 0.5A fuse in the fuse-

holder, then apply power and check the output voltages from the Power Supply Board.

All voltage checks should be made with respect to the 0V (GND) terminal. Check that the ±12V, ±6V and +17V (nominal) rails are all present.

If these are all correct, switch off and wait for about one minute to ensure that all rails have dropped to 0V.

Now plug the header into the Power Supply Board, switch on and check that one of the display LEDs is lit. You should be able to move the LEDs that are lit up and down the bargraph using the Up and Down buttons. Pressing the Mute switch should immediately cause the LED (or LEDs) to flash. Pressing Mute again (or the Up button) should stop the flashing.

It's now a good idea to check the supply rails to each IC just to make sure everything is OK. To do this, connect your multimeter's common lead to the metal tab of REG1 and check that the following voltages are present: +5V on pin 14 of IC1; +11V on pin 8 of IC2, IC3, IC5 & IC6; -11V on pin 4 of IC2, IC3, IC5 & IC6; +6V on pins 13, 14 & 15 of IC4 & IC7; and -6V on pins 7 & 19 of IC4 & IC7.

The voltages should all be within about 0.5V of the above values.

Remote control

Assuming everything checks out so far, you can now test the unit with the IR remote control.

First, you have to set the remote control so that it transmits codes that are suitable for Philips devices. Initially, it is best to set the IR remote to the TV1 code, since this is the default setting for the 6-Channel Remote Volume Control.

If you are using the Big Shot 3 IR remote from Jaycar or the Altronics AV8E (Cat. A1007), for example, you need to set it to code 191. This is done by pressing the SET and TV buttons together and then releasing them. The transmit LED will light and you then enter the number 191 using the number buttons.

Another suitable IR remote control is the Select 1 from Jaycar. This has to be set to code 11414. To do this, you first press both the CODE and Operate (red) buttons for two seconds and then release them. You then enter the numbers 11414.

Note that the Select 1 remote control will only operate the 6-Channel Remote Volume Control when it is set for the TV1 code. The Dick Smith Cat. G-1223 remote control works in similar fashion.

Having set the transmit code, check that it can operate the 6-Channel Remote Volume Control using the Volume Up/Down, Mute and Channel Up/Down buttons.

If you have a different type of remote control, start by selecting a programming number that's for Philips TV sets. It's then simply a matter of trying each number in turn until you find one that works.

Now test the remote control on your TV set. If it operates the TV set, then you will need to use another code. The choices are SAT1 and SAT2 but note that these options are available only on the multi-function remote controls such as the Altronics AV8E and the Jaycar Big Shot3 (not on the Select 1 or DSE Cat. G-1223).

The SAT1 code is 424, while the SAT2 code is 425. The selected code (424 or 425) is entered into the IR remote control after first pressing the SET and SAT switches.

The 6-Channel Remote Volume Control also needs to be changed to accept the new SAT1 or SAT2 code. **The SAT1 address is selected by pressing the Up pushbutton on the 6-Channel Remote Volume Control at power up. Similarly, SAT2 is selected by pressing the Down pushbutton at power up, while TV1 can be re-selected by pressing Mute at power up.** The selection is stored in memory and will not alter unless one of the switches is again pressed during power up.

Check that the 6-Channel Remote Volume Control can now be operated using the new code. If you have a different remote control unit to those mentioned above, select a code that operates a Philips satellite receiver and test it. If it doesn't work, try other satellite codes until you find one that does.

Finally, you can test the 6-Channel Remote Volume Control by hooking it up to the outputs of your DVD player and to your audio amplifiers. Check that the volume changes smoothly for all channels and that the sound is distortion-free and clear of any noise or hum.

Hum problems?

In most cases, you shouldn't encounter any problems with hum and

Fig.12: these two artworks for the front and rear panels are reproduced here 60% of actual size and may be enlarged to full-size for use as drilling templates on a photocopier (1.67x). If you buy a kit, then the front & rear panels will be supplied pre-punched and with screened lettering.

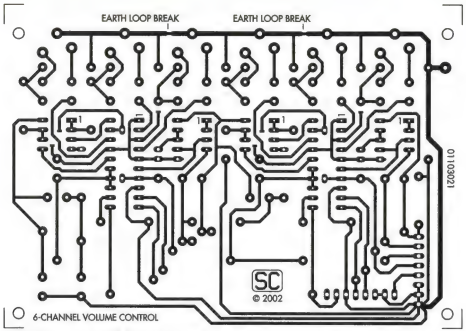


Fig.13: here are the full-size etching pattern for the three PC boards. Check your boards carefully before installing any of the parts.

noise but if you do, here's a few troubleshooting tips.

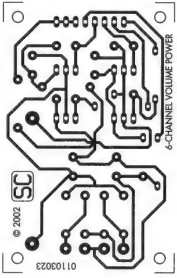
First, many power amplifiers don't have the signal earth connected back to mains earth and this can make the audio signal susceptible to mains switching noise (eg, as appliances are switched on and off). Earthing the signal at one point should reduce this effect and you can do that by connecting the earth track on the Signal Board to the signal earth terminal adjacent to the RCA connectors (see Fig.10).

Alternatively, if two or more of your amplifiers connect the signal earth to mains earth, you may get what's called a "hum loop". This will cause an audible (and annoying) hum in the audio signal.

There are several ways to get round this. First, try connecting all stereo amplifiers, the DVD player and the 6-Channel Remote Volume Control to the same power point via a multi-way power board. If that doesn't help, try disconnecting the signal earth (NOT the mains earth) from chassis in each amplifier and then use the optional signal earth connection in the 6-Channel Remote Volume Control unit as the single earthing point.

Note: for safety reasons, you must NOT disconnect the mains earth connection (if it exists) inside an amplifier chassis (or any other chassis).

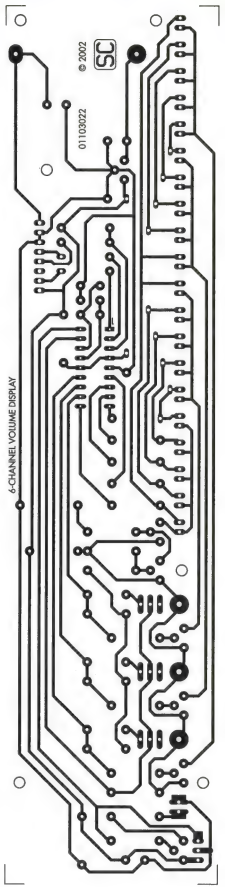
As a last resort, the earth tracks on the Signal Board can be broken. This involves cutting the tracks at the



thinned sections labelled "Earth Loop Break" and will separate the earthing into three sections. Use channels 1 & 2 for the first stereo amplifier, channels 3 & 4 for the second stereo amplifier, and channels 5 & 6 for the third stereo amplifier.

In addition, the earth connections in the leads from the DVD player to the RCA inputs of the 6-Channel Remote Volume Control will have to be disconnected. You can do that by cutting away the outside earth lugs on the RCA plugs at one end of each lead, where they connect to the 6-Channel Remote Volume Control.

Alternatively, the leads can be rewired to new RCA plugs at one end, leaving the earth braid of the cable disconnected. SC



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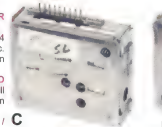

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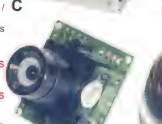

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VINTAGE RADIO

By RODNEY CHAMPNESS, VK3UG

The AWA 719C Console; Pt.2

Last month, we took a look at the impressive AWA 719C console radio and described a typical restoration. In Pt.2 this month, we detail the alignment of this complex receiver.

All the normal restoration jobs had been completed on this particular set. I'd cleaned the chassis, replaced suspect paper capacitors, tested various other components, replaced perished wiring and had the cabinet restored to its former glory. There was really only one major job left to do – the alignment of the RF, aerial, oscillator and IF circuits.

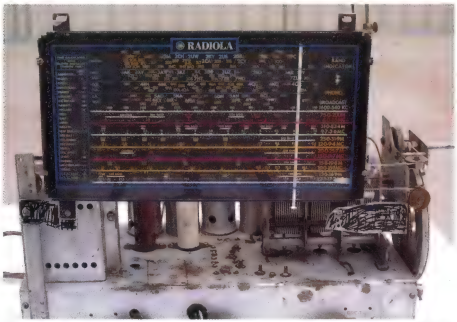
Now as anyone who has ever attempted to align one of these sets knows, it isn't a 10-minute job as it is for most superhet broadcast receivers. The average superhet set has four IF adjustments and four adjustments for the aerial and oscillator circuits, so the job is straightforward.

By contrast, the AWA "7-banders" have four IF transformer adjustments plus 19 other adjustments (and some of these are compromises) for the front end of the set. What's more, some of these adjustments have to be repeated as they tend to interact with each other. In addition, a stable RF signal generator that is well calibrated and capable of operation up to at least 23MHz is required.

Apart from the alignment taking more time, there are a few rather nasty problems that crop up during the procedure. First, the dial isn't attached to the chassis, so how do you align the front end without a dial-scale?

If you have the correct alignment data for the particular model set, it is relatively easy to do. The dial drum has a semi-circular scale around one side and there is a pointer that is alongside the scale, as can be seen in one of the photos. It's then a matter of looking up the "alignment table". For example, in one of the alignment tables, the listing for 600kHz is 19° on the drum, while for 1500kHz it is 168°.

However, as I found out, models that are claimed to be the same electrically, such as the 617T that I have and the 719C that I have been restoring, may not be identical. My set tunes from 540-1500kHz on the BC (broadcast) band, while the 719C tunes from 540-1600kHz. This means that the alignment data for my set and the 719C will be different even though the published data says they are electrically identical!



This photograph shows the two brackets (coloured with a black felt-tipped pen) that were made to hold the dial in place during alignment.

Why won't it track?

Normally, you would expect to tune the oscillator slug at the low frequency end of each band and the trimmer at the high frequency end of each band. However, while the alignment frequencies are known, the angular position of the dial drum that corresponds to the alignment frequencies is often unknown.

Initially, I went ahead and used the AWA listings but found that the coil cores and trimmers on the 719C receiver had to be altered considerably to get the set operating as per the alignment table. This seemed a bit strange, so I held the dial mechanism in approximately its correct position and attached the pointer to the dial cord. The alignment points were nowhere near where they should have been.

It was then that I realised that the

719C covers from 540-1600kHz instead of 540-1500kHz as for my 617T, as noted above. And that explained why I couldn't get it to track correctly. The 719C I was restoring is obviously a later set due to the extended broadcast band calibrations, therefore the degree settings would be different on the dial drum.

But what settings should I use? This was getting messy.

A tuning aid

So how I could align this set without the relevant set of alignment instructions? After some thinking, I came up with the idea of mounting the dial scale onto the receiver chassis by some means. I had some scrap 24-gauge galvanised flashing (plumbers or hardware stores often have it available) and decided that I could make some simple brackets for the job. It really is a pity the chassis design wasn't similar to the 805G and other radiogram models, where the dial scale was firmly attached to the chassis assembly – alignment would have been so much easier.

The brackets that I made can be clearly seen in one of the photos (they've been coloured black using a felt-tipped pen). At the lefthand end, one bracket is attached (using a nut and bolt) to a vertical piece of metal that supports a dial scale pulley. The other end of this bracket then goes to an existing bracket at the bottom of the dial-scale.

At the other end, the second home-made bracket goes between another existing dial-scale bracket and a plate which carries the dial-drive mechanism. It was necessary to drill a small hole near the front bottom of this plate to accept a nut and bolt to secure the second bracket in place.

Provided you get the brackets right, the dial drive will work quite well. Remember however, that this is a rather flimsy arrangement, so take care to ensure that no stress is applied to the assembly. It should be perfectly adequate while the alignment procedure is carried out, however.

Tuning the IF stage

With the gang closed, the pointer is attached so that it is just below 540kHz (Kc/s) on the dial. This done, the IF transformers are tackled first. With the set turned off, attach a digital multimeter (DMM) (set to the 20V DC range) between the AGC/AVC line and chassis using clip leads. An ideal spot is across C37, with the negative lead going to the unearthed side of the capacitor. With the set turned on, the DMM should read about -3V, which is the standing bias on the front-end valves.

The dial drum has a semi-circular scale (marked in degrees) around one side and this is used in conjunction with the "alignment table" (see Table 1) when making alignment adjustments. The holes adjacent to the two arrows at bottom, left of the chassis allow access to the 9MHz aerial and RF trimmers.

Next, attach the signal generator to the aerial terminal of the receiver, set it to 455kHz with (tone) modulation and increase the power until the tone is heard from the speaker. You may have to tune around 455kHz on the signal generator to get a response, although I usually find that most sets are close enough to 455kHz in their alignment to make this step unnecessary.

Now increase the output on 455kHz (if you can hear it on that frequency) until the DMM shows an increased reading. (It is possible to "walk" the IF frequency up or down to 455kHz if it is way off frequency; eg, if there is a problem with the IF stage due to someone's fiddling or if there is a fault). That done, adjust the tuning slugs (using a small plastic screwdriver) in the top and bottom of each IF transformer

This under-chassis view shows the locations of the aerial and RF coil trimmers (white & light green type respectively), the oscillator cores (yellow type) and the trimmers (red type). The numbers in the brackets refer to the corresponding adjustment number in the alignment table.

for a maximum reading on the meter.

All being well with the IF transformers, a peak will be found within a turn or two either side of the initial settings. The screws can then be locked in position with a dab of plastic cement or nail polish.

RF, aerial & oscillator circuits

Now we come to the "fun" part – the alignment of the front-end of the set. Table 1 (at the end of this article) is an extract from a set of alignment instructions for the 611-T and a few other sets. This table can be used to tune the RF, aerial and oscillator sections of the set.

However, although I used this information to tune my 617-T, some of the component numbers for the 611-T are different.

The procedure is as follows. Using the 611-T alignment table, switch the set to the broadcast band and turn the dial drum until 19° appears under the small pointer. This is the 600kHz mark and the dial pointer should also be aligned to the 600kHz mark on the dial scale. Note that I have used "kHz" and "MHz" abbreviations in this article, whereas the dial and tuning instructions show "Kc/s" and "Mc/s".

It is now possible to either use the alignment table or do it directly from the dial-scale that has been temporarily attached to the chassis via the brackets described earlier. There is no problem in aligning the set using the bracket method. However, if you use the alignment table and the calibration table for the 611-T, it may be correct for the model that you are aligning, or it may not be – as was the case with the 719C.

The alignment table is used for each band but the dial calibrations and not the degree settings must be used to align the circuits correctly. I feel much more confident this way.

The location of each of the adjustments is not shown on any literature that I've been able to access, so diagrams 2 and 3 have been drawn to show where each of the 19 adjustments are located. This has made it much easier for me to do this job and should help you too.

Note that the oscillator adjustments are all made from above the chassis, while the RF and aerial trimmers are under the chassis, as can be seen in the photograph at left. Note also that the 9MHz aerial and RF trimmers are accessed through the end of the chassis, as shown by the arrows in the photograph of the dial scale.

The broadcast band is aligned as per steps 5, 6, 7 & 8 of the alignment table. I connect the receiver to a "typical" antenna, then clamp the output lead from the signal generator over the insulation on the antenna lead. That way, the generator has little effect on the tuning of the aerial coils, although the generator does have to be wound up further to get a reasonable level into the receiver to actuate the AGC.

In practice, the generator is set to each of the frequencies shown in the alignment data in turn. Note that it's necessary to repeat the adjustments again for maximum reading on the DMM. In fact, you may need to repeat the procedure several times before you are happy that there is no interaction between the individual adjustments.

After the broadcast band been completed, the 17.7-22.3MHz band can be

aligned. This involves setting the dial to 17.8MHz (or 18°) and doing adjustments 9, 10 & 11. You then set the dial to 21MHz and do adjustment 12.

On the 15.0-19.0MHz band there is only one adjustment and that is the oscillator at 15.2MHz (adjustment 13).

On the 11.7-15.0MHz band, all the circuits are adjusted at 11.8MHz. The adjustment numbers are 14, 15 & 16.

Moving now to the 9.4-12.0MHz band, again there is only one adjustment and that is the oscillator on 9.5MHz (adjustment 17).

On the 3.6-9.7MHz band, the dial is set to 9MHz and you do the adjustments 18, 19 & 20. The dial is then set to 4MHz for adjustment 21. Personally, I would do 21 first (which is conventional wisdom), then 18 and then go between these two until I was satisfied that the oscillator was tracking correctly before doing adjustments 19 and 20.

We are now nearly at the end of the alignment procedure. On the 1.5-4MHz band there are two adjustments, both involving the oscillator. Adjust the oscillator core at 1.6 MHz (adjustment 22) and then the trimmer (adjustment 23) at 3.7MHz. Re-check after adjusting both that the first one is still correct and if not, readjust it.

The other adjustment will quite likely be out again but not as much as before. Going between the two adjustments will quite quickly get the oscillator circuit tracking fairly accurately across the band. This technique applies to any of the bands where the oscillator is adjusted at both the low and high ends of the band.

Finally, recheck the broadcast band alignment if the 21MHz oscillator trimmer has had to be altered. Note that the information on the 611-T indicates that the trimmer is C9 but in the 617T and 719C it is C12.

Photo Gallery

AIRZONE MODEL 300: manufactured by Airzone (Sydney) in 1934, the Model 300 features a classic wooden "Cathedral" style cabinet. The circuit is a 4-valve superhet with the following valve types: 57 autodyne mixer, 58 IF amplifier, 59 anode bend detector/ audio output and an 80 rectifier.

The compromises

Normally, the front end of a set with seven bands and an RF stage will have six adjustments per band, making a total of 42 adjustments. However, there are only 19 adjustments in these particular sets. There are several reasons for this.

First, there are no aerial or RF stage adjustments at the low-frequency end of each band. This means that if the coils are not exactly matched, the performance at the low-frequency end of

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TABLE 1: ALIGNMENT TABLE

Alignment Order	Test Ins. Connect To Receiver	Frequency Setting	Band Setting	Calibration Scale Setting	Circuit To Adjust	Adjustment Symbol	Adjust To Obtain
1	6J8G Cap*	455kHz	Broadcast	0	2nd IF Trans.	Core L36	Max. Peak
2	6J8G Cap*	455kHz	Broadcast	0	2nd IF Trans.	Core L35	Max. Peak
3	6J8G Cap*	455kHz	Broadcast	0	1st IF Trans.	Core L34	Max. Peak
4	6J8G Cap*	455kHz	Broadcast	0	1st IF Trans.	Core L33	Max. Peak
Recheck 1, 2, 3 & 4							
5	Aerial	600kHz	Broadcast	19	Oscillator**	Core L31	Calibration
6	Aerial	1500kHz	Broadcast	168	Oscillator	C11	Calibration
7	Aerial	1450kHz	Broadcast	158	Radio Freq.	C27	Max. Peak
8	Aerial	1450kHz	Broadcast	158	Aerial	C7	Max. Peak
Recheck 5, 6, 7 & 8							
9	Aerial	17.8MHz	22.3-17.7MHz	18	Oscillator	Core L19	Calibration
10	Aerial	17.8MHz	22.3-17.7MHz	18	Radio Freq.**	C24	Max. Peak
11	Aerial	17.8MHz	22.3-17.7MHz	18	Aerial	C4	Max. Peak
12	Aerial	21.0MHz	22.3-17.7MHz	149	Oscillator	C9	Calibration
13	Aerial	15.2MHz	19.0-15.0MHz	27	Oscillator	Core L21	Calibration
14	Aerial	11.8MHz	15.0-11.7MHz	25	Oscillator	Core L23	Calibration
15	Aerial	11.8MHz	15.0-11.7MHz	25	Radio Freq.**	C25	Max. Peak
16	Aerial	11.8MHz	15.0-11.7MHz	25	Aerial	C5	Max. Peak
17	Aerial	9.5MHz	12.0-9.4MHz	24	Oscillator	Core L25	Calibration
18	Aerial	9.0MHz	9.7-3.6MHz	156	Oscillator	C13	Calibration
19	Aerial	9.0MHz	9.7-3.6MHz	156	Radio Freq.**	C26	Max. Peak
20	Aerial	9.0MHz	9.7-3.6MHz	156	Aerial	C6	Max. Peak
21	Aerial	4.0MHz	9.7-3.6MHz	19	Oscillator	Core L27	Calibration
Recheck 18, 19, 20 & 21							
22	Aerial	1.6MHz	4.0-1.5MHz	15	Oscillator	Core L29	Calibration
23	Aerial	3.7MHz	4.0-1.5MHz	153	Oscillator	C14	Calibration
Recheck 22 & 23							

Finally, recheck broadcast band. This is necessary only if the setting of C9 has been altered.
* Rock the tuning control back and forth through the signal.
** With grid clip connected. A .001uF capacitor should be connected in series with the 'high' side of the test instrument.
The column headed 'Calibration Scale Setting' refers to the 180 degree scale on the ganged tuning capacitor drive drum. In taking readings on this scale, read from the right-hand edge of the pointer; ie, the edge nearest the rear of the chassis. Check the setting of the drum before taking readings. The zero mark should be opposite the pointer with the tuning capacitor fully closed.

Photo Gallery

GENERAL ELECTRIC MODEL 110: this receiver was made by AWA (Sydney) in 1932 and has the distinction of being the first to be housed in an Australian-made Bakelite cabinet. The same chassis was also marketed under the AWA brand as the Model C87. The circuit is a 4-valve TRF with the following valves: 35 RF amplifier, 24 detector, 47 output and an 80 rectifier.

the band can be inferior to that obtained at the high-frequency end.

Second, on some bands, there are only adjustments for the oscillator at both ends of the band; eg, the 1.5-4.0MHz band which has no RF or aerial coil adjustments at all. This can be quite a compromise if the coils aren't accurately matched.

In fact, I found that if I wanted good performance at the high end of the band in the 719C, I had to compromise with the oscillator frequency. For this particular receiver, I found that in order to get good RF sensitivity, I had to adjust the oscillator so that the receiver was actually on 3.65MHz when the dial said it was 3.7MHz.

Third, on the 9.4-12.0MHz and 15.0-19.0MHz bands, there is only one adjustment and that is for the oscillator at the low-frequency end. Hopefully the set will track correctly across each of these bands but that's really a faint hope I'm afraid. The value of C15 is quite critical and by altering it, it is possible to correct the tracking to some degree.

C1 and C22 could also be played with to improve the tracking of the RF and aerial circuits on shortwave as well. However, it is not an easy task and unless you are a bit of a masochist, it is left well alone.

Summary

These sets overcome the deficiencies in their tuned circuits by sheer brute force but are not as sensitive as some sets. In addition, the tuning mechanism is free-running and tuning shortwave stations is a dream compared to the "hair's-breadth" tuning on a conventional dual-wave set. And although the tuning accuracy isn't as good as it should be, it is better than on most receivers. Most listeners rarely knew the frequencies of the shortwave stations they wanted to listen to anyway.

Finally, they are an impressive receiver to look at and well worth a place in your vintage radio collection. If you've always wanted to align your AWA 7-bander, this article should be all the incentive you need. **SC**

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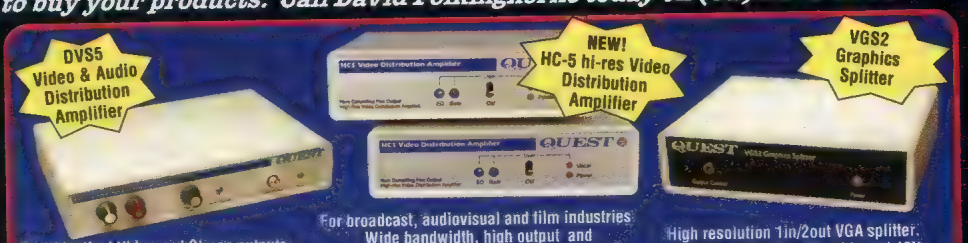

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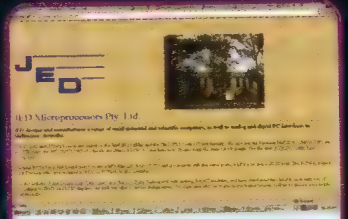

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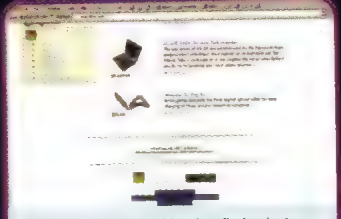

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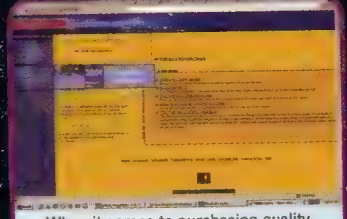

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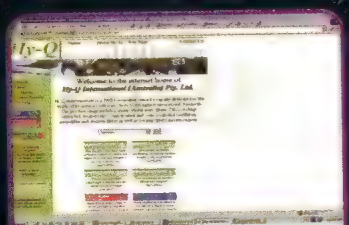

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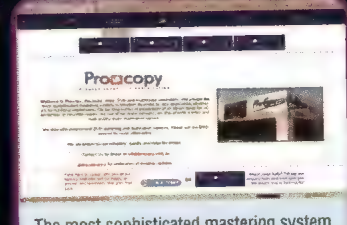

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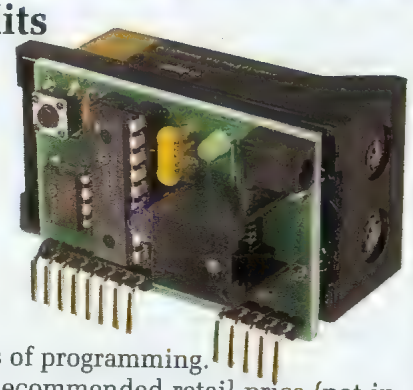

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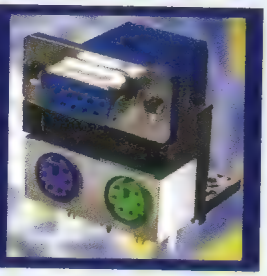

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The next model up is the HT9102S, which offers two wells; one for a reference thermometer to increase the accuracy. Again the unit is very light (1.8kg) and very easy to operate.

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For even higher precision, a contact calibration well is located directly behind the blackbody surface. Using an optional digital RTD thermometer such as the Hart HT1521 and a calibrated secondary probe, accuracies of ± 0.1°C can be achieved.

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Jaycar's new 2002 catalog

Packaged with this issue of SILICON CHIP (or mailed separately to subscribers) is (or was!) the new 2002 Jaycar Electronics Engineering Catalog.

At 356 pages, it is the largest and most comprehensive yet produced by the company and is crammed with over 5,000 products and hundreds of new, interesting & innovative items.

All product ranges has been expanded and improved, from individual components to kits, projects and fully functional items including test equipment, alarm systems, car sound, home audio, surveillance equipment and much more. Of particular interest are the Cold Cathode Fluorescent tubes which are available in a range of colours.

If your copy of the catalog has already been purloined, or you want another copy, it is available from any Jaycar store or via their website for $2.95. A $2.50 CD-ROM version with be available in May. It is fully searchable and features an easy-to-use browser style interface and 'on-line' pricing updates.

For more information, contact your nearest Jaycar store or visit their website at www.jaycar.com.au

Clamp-On Power Meter aids in Energy Conservation

The CW120 series of low-cost clamp-on power meters from Yokogawa have been designed as simple tools capable of measuring power values and instantaneous values.

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Data can be saved at 1-second intervals. This allows the CW120 to respond quickly to load fluctuations and measure transient responses in equipment. Having support for large capacity flash ATA memory cards, measurements can be taken by the CW120 for extended time periods.

The CW120 also comes with a Windows-based software package, known as Toolbox.

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Tandy's Microscope Set

In these days of all-electronic kits and toys it's nice to see someone come up with a product to challenge the mind which is *not* microprocessor-controlled! This 9.5-inch diecase microscope from Tandy has a 10x, 30x & 60x objective lens and 67 items to get you started, including slicers, blank slides, dissecting needles, filters, prepared slides and much more.

It's available from all Tandy Electronics stores throughout Australia for only $64.95 and comes in a hard plastic carry case to store the microscope and all the goodies.

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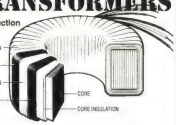

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The NetServe 300 is ideally suited for firewalls, gateways, IP servers or thin clients.

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Among the interfaces are: a CRT interface supporting non-interlaced CRTs up to 1024 x 768 resolution and an audio interface compliant with AC97.2 consisting of Mic In, Line In and Line Out.

Dual Intel 10/100Base Ethernet interfaces and SSD interface supporting Type I/II Compact Flash are also included.

2 x USB, 2 x serial and 1 x LPT ports are also supplied.

The NetServe 300 requires only a single +5V, and a stand-alone power supply is included in the price. The whole unit measures just 178 (W) x 65(H) x 106 (D) and weighs 400g.

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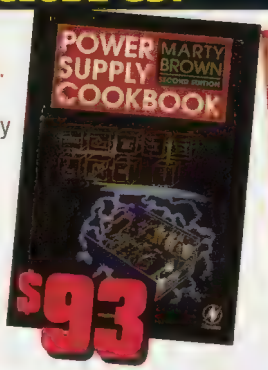

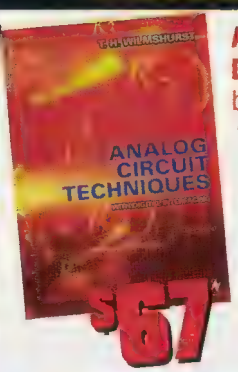

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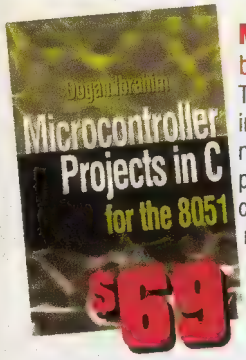

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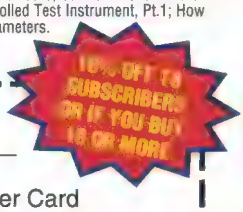

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November 1996: 8-Channel Stereo Mixer, Pt.1; Low-Cost Fluorescent Light Inverter; Repairing Domestic Light Dimmers; Multi-Media Sound System, Pt.2; 600W DC-DC Converter For Car Hifi Systems, Pt.2.

December 1996: Active Filter Cleans Up Your CW Reception; A Fast Clock For Railway Modellers; Laser Pistol & Electronic Target; Build A Sound Level Meter; 8-Channel Stereo Mixer, Pt.2; Index To Vol.9.

January 1997: How To Network Your PC; Control Panel For Multiple Smoke Alarms, Pt.1; Build A Radio Data Source; Computer Controlled Dual Power Supply, Pt.1; Dig-Temp Monitors Eight Temperatures.

February 1997: PC-Controlled Moving Message Display; Computer Controlled Dual Power Supply, Pt.2; Alert-A-Phone Loud Sounding Telephone Alarm; Control Panel For Multiple Smoke Alarms, Pt.2.

March 1997: Driving A Computer By Remote Control: Plastic Power FX Amplifier (175W); Signalling & Lighting For Model Railways; Build A Jumbo LED Clock; Cathode Ray Oscilloscopes, Pt.7.

April 1997: Simple Timer With No ICs; Digital Voltmeter For Cars; Loudspeaker Protector For Stereo Amplifiers; Model Train Controller; A Look At Signal Tracing; Pt.2; Cathode Ray Oscilloscopes, Pt.8.

May 1997: Neon Tube Modulator For Light Systems; Traffic Lights For A Model Intersection; The Spacewriter – It Writes Messages In Thin Air; A Look At Signal Tracing; Pt.2; Cathode Ray Oscilloscopes, Pt.9.

June 1997: PC-Controlled Thermometer/Thermostat; TV Pattern Generator, Pt.1; Audio/RF Millivoltmeter; Non-Current-Tripped Speed Controller For 12V/24V Motors; Manual Control Circuit For Stepper Motors.

July 1997: Infrared Remote Volume Control; A Flexible Interface Card For PCs; Points Controller For Model Railways; Colour TV Pattern Generator, Pt.2; Ac-In-Line Meter For Radio Control Receivers.

August 1997: The Bass Barrel Subwoofer; 500 Watt Audio Power Amplifier Module; A TENs Unit For Pain Relief, Addressable PC Card For Stepper Motor Control; Remote Controlled Gates For Your Home.

September 1997: Multi-Spark Capacitor Discharge Ignition; 500W Audio Power Amplifier, Pt.2; A Video Security System For Your Home; PC Card For Controlling Two Stepper Motors; HiFi On A Budget.

October 1997: Build A 5-Digit Tachometer; Add Central Locking To Your Car; PC-Controlled 4-Channel Voltmeter; 500W Audio Power Amplifier, Pt.3; Customising The Windows 95 Start Menu.

November 1997: Heavy Duty 10A 240VAC Motor Speed Controller; Easy-To-Use Cable & Wiring Tester; Build A Musical Doorbell; Replacing Foam Speaker Surrounds; Understanding Electric Lighting Pt.1.

December 1997: Speed Alarm For Cars; 2-Axis Robot With Gripper; Stepper Motor Driver With Onboard Buffer; Power Supply For Stepper Motor Cards; Understanding Electric Lighting Pt.2; Index To Vol.10.

January 1998: Build Your Own 4-Channel Lightshow, Pt.1 (runs off 12VDC or 12VAC); Command Control System For Model Railways, Pt.1; Pan Controller For CCD Cameras.

February 1998: Multi-Purpose Fast Battery Charger, Pt.1; Telephone Exchange Simulator For Testing; Command Control System For Model Railways, Pt.2; Build Your Own 4-Channel Lightshow, Pt.2.

April 1998: Automatic Garage Door Opener, Pt.1; 40V 8A Adjustable Power Supply, Pt.1; PC-Controlled 0-30kHz Sinewave Generator; Build A Laser Light Show; Understanding Electric Lighting; Pt.6.

May 1998: Troubleshooting Your PC, Pt.1; Build A 3-LED Logic Probe; Automatic Garage Door Opener, Pt.2; Command Control For Model Railways, Pt.4; 40V 8A Adjustable Power Supply, Pt.2.

June 1998: Troubleshooting Your PC, Pt.2; Universal High Energy Ignition System; The Roadies' Friend Cable Tester; Universal Stepper Motor Controller; Command Control System For Model Railways, Pt.5.

July 1998: Troubleshooting Your PC, Pt.3; Build A Heat Controller; 15-Watt Per Channel Class-A Audio Amplifier Module, Pt.1; Simple Charger For 6V & 12V SLA Batteries; Automatic Semiconductor Analyser; Understanding Electric Lighting, Pt.7.

August 1998: Troubleshooting Your PC, Pt.4 (Adding Extra Memory); Simple I/O Card With Automatic Data Logging; Build A Beat Triggered Strobe; 15-Watt Per Channel Class-A Stereo Amplifier, Pt.2.

September 1998: Troubleshooting Your PC, Pt.5 (Software Problems & DOS Games); 8-Stocked Fish-Filter Alarm; A Wah-Wah Pedal For Your Guitar; Build A Plasma Display Or Jacob's Ladder; Gear Change Indicator For Cars; Capacity Indicator For Rechargeable Batteries.

October 1998: Lab Quality AC Millivoltmeter, Pt.1; PC-Controlled Stress-O-Meter; Versatile Electronic Guitar Limiter; 12V Flocke Charger For Float Conditions; Adding An External Battery Pack To Your Flashgun.

November 1998: The Christmas Star; A Turbo Timer For Cars; Build A Poker Machine, Pt.1; FM Transmitter For Musicians; Lab Quality AC Millivoltmeter, Pt.2; Setting Up A LAN Using TCP/IP; Understanding Electric Lighting, Pt.9; Improving AM Radio Reception, Pt.1.

December 1998: Protect Your Car With The Engine Immobiliser Mk.2; Thermocouple Adaptor For DMMs; A Regulated 12V DC Plugpack; Build Your Own Poker Machine, Pt.2; Improving AM Radio Reception, Pt.2; Mixer Module For F3B Glider Operations.

January 1999: High-Voltage Megohm Tester; Getting Started With BASIC Stamp; LED Bargraph Tachometer; Low-Cost Audio Amplifier Immobiliser; Improving AM Radio Reception, Pt.3.

March 1999: Getting Started With Linux; Pt.1; Build A Digital Anemometer; 3-Channel Current Monitor With Data Logging; Simple DIY PIC Programmer; Easy-To-Build Audio Compressor; Low Distortion Audio Signal Generator, Pt.2; Electric Lighting, Pt.12.

April 1999: Getting Started With Linux; Pt.2; High-Power Electric Fence Controller; Bass Cube Subwoofer; Programmable Thermostat/Thermometer; Build An Infrared Remote Control, Pt.1; Index To Vol.11.

May 1999: The Line Dancer Robot; An X-Y Table With Stepper Motor Control, Pt.1; Three Electric Fence Testers; Heart Of LEDs; Build A Carbon Monoxide Alarm; Getting Started With Linux; Pt.3.

June 1999: FM Radio Tuner Card For PCs; X-Y Table With Stepper Motor Control, Pt.2; Programmable Ignition Timing Module For Cars, Pt.1; Hard Disk Drive Upgrades Without Reinstalling Software?

July 1999: Build A Dog Silencer; 10µH to 19.99mH Inductance Meter; Build An Audio-Video Transmitter; Programmable Ignition Timing Module For Cars, Pt.2; X-Y Table With Stepper Motor Control, Pt.3.

August 1999: Remote Modem Controller; Daytime Running Lights For Cars; Build A PC Monitor Checker; Switching Temperature Controller; XYZ Table With Stepper Motor Control, Pt.4; Electric Lighting, Pt.14.

September 1999: Automatic Addressing On TCP/IP Networks; Autonomous Mini-Sub, Pt.1; Voice Direct Speech Recognition Module; Digital Electrolytic Capacitance Meter; XYZ Table With Stepper Motor Control, Pt.5; Peltier-Powered Car Cooler.

October 1999: Build The Railpower Model Train Controller, Pt.1; Semiconductor Curve Tracer; Autonomous Mini-Sub, Pt.2; XYZ Table With Stepper Motor Control, Pt.6; Introducing Home Theatre.

November 1999: Electric Lighting, Pt.15; Setting Up An Email Server; Speed Alarm For Cars, Pt.2; Build The LED Christmas Tree; Build An Intercom Station Expander; Foldback Loudspeaker System For Musicians; Railpower Model Train Controller, Pt.2.

December 1999: Electric Lighting, Pt.16; Build A Solar Panel Regulator; The PC Powerbase (gives feed +12V, +9V, +6V & +5V rails); The Fortune Finder Metal-Locator; Speed Alarm For Cars, Pt.2; Railpower Model Train Controller, Pt.3; Index To Volume 12.

January 2000: Spring Reverberation Module; An Audio-Video Test Generator; Build The Psion Programmable Robot; A Parallel Port Interface Card; Off-Hook Indicator For Telephone Lines.

February 2000: Multi-Sector Sprinkler Controller: A Digital Voltmeter For Your Car; An Ultrasonic Parking Radar; Build A Safety Switch Checker; Build A Sinewave Wave Generator.

March 2000: Resurrecting An Old Computer; Low Distortion 100W Amplifier Module, Pt.1; Electronic Wind Vane With 16-LED Display; Glowplug Driver For Powered Models; The Qt7np Car Computer, Pt.1.

May 2000: Ultra-LD Stereo Amplifier, Pt.2; Build A LED Dice (With PIC Microcontroller); Low-Cost AT Keyboard Translator (Converts IBM Scan-Codes To ASCII); 50A Motor Speed Controller For Models.

June 2000: Automatic Rain Gauge With Digital Readout; Parallel Port VHF FM Receiver; LiT Powerhouse Switchmode Power Supply (1.23V to 40V) Pt.1; CD Compressor For Cars Or The Home.

July 2000: A Moving Message Display; Compact Fluorescent Lamp Driver; Bi-Cheapo Microcontroller Lead Tester; LiT Powerhouse Switchmode Power Supply (1.23V to 40V) Pt.2.

August 2000: Build A Theremin For Really Eerie Sounds; Come In Spinner (writes messages in "thin-air"); Proximity Switch For 240VAC Lamps; Structured Cabling For Computer Networks.

September 2000: Build A Swimming Pool Alarm; An 8-Channel PC Relay Board; Fuel Mixture Display For Cars, Pt.1; Protoboards – The Easy Way Into Electronics, Pt.1; Cybug The Solar Fly.

October 2000: Guitar Jammer For Practice & Jam Sessions; Boozo Buster Breath Tester; A Wash/Rinse/Spin Programmer Inspection Camera; A Free-Air Subwoofer In Your Car; Fuel Mixture Display For Cars, Pt.2; Protoboards – The Easy Way Into Electronics, Pt.2.

November 2000: Santa & Rudolf Chirpsie Display; 2-Channel Guitar Preamplifier, Pt.1; Message Bank & Missed Call Alert; Electronic Thermostat; Protoboards – The Easy Way Into Electronics, Pt.3.

December 2000: Home Networking For Shared Internet Access; Build A Bright-White LED Torch; 2-Channel Guitar Preamplifier, Pt.2 (Digital Reverb); Driving An LCD From The Parallel Port; Build A Morse Clock; Protoboards – The Easy Way Into Electronics, Pt.4; Index To Vol.13.

January 2001: How To Transfer LPs & Tapes To CD; The LP Doctor – Clean Up Clicks & Pops, Pt.1; Arbitrary Waveform Generator; 2-Channel Guitar Preamplifier, Pt.3; PIC Programmer & TestBed.

February 2001: How To Observe Meteors Using Junked Gear; An Easy Way To Make PC Boards; Li'l Pulser Train Controller; Midi-Mate – A MIDI Interface For PCs; Build The Bass Blazer; 2-Metre Elevated Groundplane Antenna; The LP Doctor – Clean Up Clicks & Pops, Pt.2.

March 2001: Driving Your Phone From A PC; Making Photo Resist PC Boards At Home; Big-Digit 12/24 Hour Clock; Parallel Port PIC Programmer; Ed Breukerboek's PC Boards – The Easy Way Into Electronics, Pt.5; More MIDI – A Simple MIDI Expansion Box.

April 2001: A GPS Module For Your PC; Dr Video – An Easy-To-Build Video Stabiliser; A Tremolo Unit For Musicians; Minimiter FM Stereo Transmitter; Intelligent Nicad Battery Charger; Computer Tips – Tweaking Internet Connection Sharing.

May 2001: Powerful 12V Mini Stereo Amplifier; Microcontroller-Based 4-Digit Counter Modules; Two White-LED Torches That Build; PowerPak – A Multi-Voltage Power Supply; Using Linux To Share An Internet Connection, Pt.1; Computer Tips – Tweaking Windows With Tweak UI.

June 2001: Fast Universal Battery Charger, Pt.1; Phonoms – Call, Listen In & Record Phone Calls On Your PC; Li'l Snooper — A Low-Cost Automatic Camera Switcher; Using Linux To Share An Internet Connection, Pt.2; A PC To Die For, Pt.1 (Building Your Own PC).

July 2001: The HeartMate Heart Rate Monitor; Do Not Disturb Telephone Timer; Pic-Toc – A Simple Alarm Clock; Fast Universal Battery Charger, Pt.2; A PC To Die For, Pt.2; Backing Up Your Hard Disk.

August 2001: Direct Injection Box For Musicians; Build A 200W Mosfet Amplifier Module; Headlight Reminder For Cars; 40MHz 6-Digit Frequency Counter; A PC To Die For, Pt.3; Using Linux To Share An Internet Connection, Pt.3.

September 2001: Making MP3s – Rippers & Encoders; Build Your Own MP3 Jukebox, Pt.1; PC-Controlled Mains Switch; Personal Noise Level Meter; Sensitive Speech Recorder; Cheapo Snooper Stereo Microphone; Using Linux To Share An Internet Connection, Pt.3.

October 2001: A Video Microscope From Scrounged Parts; Build Your Own MP3 Jukebox, Pt.2; Super-Sensitive Body Detector; An Automotive Thermometer; Programming Languages For Atmel Microcomputers; Building Your Own PC – One Man's Approach.

November 2001: Ultra-LD 100W RMS/Channel Stereo Amplifier, Pt.1; Neon Tube Modulator For Cars; Low-Cost Audio/Video Distribution Amplifier; Short Message Recorder Player; Computer Tips.

December 2001: A Look At Windows XP; Build A PC Infrared Transceiver; Ultra-LD 100W RMS/Ch Stereo Amplifier, Pt.2; Pardy Lights – An Intriguing Lighting Effect; Remote Control — Learning About It.

January 2002: Touch And/Or Remote-Controlled Light Dimmer, Pt.1; A Cheap 'n' Easy Motorbike Alarm; 100W RMS/Channel Stereo Amplifier, Pt.3; Build A Raucous Alarm; Tracking Down Computer Software Problems; Electronic Audio Terms; FAQs On The PC's Soundcard.

February 2002: 10-Channel IR Remote Control Receiver; 2.4GHz High-Power Audio-Video Link; Assemble Your Own 2-Way Tower Speakers; Touch And/Or Remote-Controlled Light Dimmer, Pt.2; Booting A PC Without A Keyboard; 4-Way Event Timer.

March 2002: Mighty Midget Audio Amplifier Module; The Itsy-Bitsy USB Gamp; 6-Channel Motor Speed Controller; Pt.1; RIAA Preamplifier For Magnetic Cartridges; 12/24V Intelligent Solar Power Battery Charger; Escenade Audio Tones Using Your PC's Soundcard.

PLEASE NOTE: November 1987 to March 1989, June 1989, August 1989, December 1989, May 1990, February 1991, June 1991, August 1991, January 1992, February 1992, July 1992, August 1992, September 1992, November 1992, December 1992, January 1993, May 1993, February 1996, March 1998 and February 1999 are now sold out. All other issues are presently in stock. For readers wanting articles from sold-out issues, we can supply photostat copies (or fear sheets) at $7.70 per article (includes p&p). When supplying photostat articles or back copies, we automatically supply any relevant notes & errata at no extra charge. A complete index to all articles published to date is available on floppy disk for $11 including p&p, or can be downloaded free from our web site: www.siliconchip.com.au

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Playing 78s with the LP Doctor

I have built the LP Doctor described in the January 2001 issue and may I say that your efforts on this project have been tremendous. I present nostalgic music by playing 78 RPM recordings which are broadcast to air on our community radio station. I still have a problem getting rid of surface noise on 78s. The LP Doctor does a great job on clicks and pops but as you suggest in your article on the subject, it does little on surface noise.

I have done a bit of playing around with a filter published in ETI of September 1980. I managed to achieve fairly reasonable results by using the filter set to 5kHz and incorporating the LPD for dealing with the clicks and pops. I feed the turntable audio into the LPD and I feed the filter by paralleling the LPD's output (ie, by bringing the L + R positives together and so the commons together).

One assumes by doing that this I have created a reasonably effective common mode rejection filter. It does make a difference in regard to the 78s' surface noise.

On a related subject, I have constructed several RIAA phono preamps (from the April 1994 issue) and they are terrific, the low noise factor in particular. My problem is that though they work splendidly playing vinyls, they don't like the audio from 78s. I assume that the 78s cause the cartridge to produce a higher voltage than vinyl records. This tends to create clipping/distortion especially on the highs of a 78 recording (eg, a tenor hitting a high note).

At first I thought I had a faulty cartridge but not so. I have tried several magnetic cartridges including high quality Stanton and Shure types, which produced little difference. I was once told by an old broadcast engineer that the equalisation required for 78s is different to that required for LPs/vinyls. I managed to solve the problem by installing a pad on the tagstrip under the turntable unit. (K. J., Epping, Vic).

● It is true that 78 RPM records will generate higher signal outputs from the cartridge and therefore there will be more likelihood of overload in the preamplifier. The solution to this is to reduce the gain of the preamplifier by increasing the value of the feedback resistor (R4) from 390Ω to 1kΩ or more. Do not reduce the output of the cartridge as you have because this will degrade the overall performance.

The equalisation was different for 78s; in fact there were quite a number of different equalisation curves in use before LPs came onto the scene and the RIAA curve became the standard. Each recording company had its own recording characteristic and therefore the required equalisation could be quite different from the RIAA curve. You can find more info on the this subject in the esteemed "Radiotron Designers Handbook" but the more you look into it, the more it becomes a can of worms.

To minimise surface noise from a stereo cartridge when playing 78s, the cartridge left and right channels should be paralleled and then fed to a single channel of the preamplifier. Paralleling the outputs of the LP Doctor is not recommended.

You can increase the treble filtering from the LP Doctor by changing 150pF capacitor associated with IC5b & IC7b to 330pF and the 560pF to .0012µF. This is a simpler and more effective approach than using the ETI filter.

Video mixer circuit wanted

I would like a circuit that would allow the mixing of two separate video signals into one (a video fader in the same manner as the familiar audio fader). I realise there is a problem with the synchronising of the signals and there would in all probability be a varying black horizontal and/or vertical bar as a result if the same circuitry as for audio were used. Could this be overcome with some sort of auto delay on one of the signals?

Please put on your thinking caps and provide me, and many others interested, I'm sure, with a practical answer. (J. S., Woodville West, SA).

● As you are aware, the two video signals must be locked together. In practice, the only way of doing this is to feed one of the video signals into a frame store so that it can be fed out in sync with the second video signal.

Frame stores are a feature of the "picture-in-picture" chipsets used in upmarket TV sets. However, while a PIP chipset could form the heart of a practical video mixer, we have not produced such a design and the chipsets are not readily available.

Immobilising a V6 Commodore

My nephew has purchased an engine immobiliser & keypad kit to be fitted to his 1994 VR Commodore 1994. At present, we are unsure what wire is the output from the coil to connect to the immobiliser. He has purchased a manual however it only shows the active from the ignition switch. Have you fitted (or had fitted) a unit to a similar car? Could you please inform us what to do. (G. R., via email).

● As described in our feature article on the Commodore in the December 1988 issue, the Commodore V6 uses three double-ended ignition coils. Hence an immobiliser either has to kill all three coils or kill the signal from the Hall Effect pickup on the harmonic balancer. We think the safest (and most expensive approach) would be to use three high-voltage high-current diodes to kill the three coils with the one high voltage transistor in the immobiliser circuit.

Peak hold for tachometer

I would like to know whether a peak hold function could be added to the tachometer circuit featured in the April 2000 issue.

I would like to use the unit in a Formula 500 Speedway car which is powered by a single-cylinder 2-stroke engine. Different tracks require different gearing and this feature would be ideal for checking for peak RPM – it becomes very difficult to keep an eye on the tacho when peak revs come at the end of the straight, right when you're sliding into corners and trying to avoid cars in front of you, while getting mud thrown at your visor. (J. H., Perth, WA).

● Unfortunately, the entire memory capacity of the microcontroller used in the tachometer circuit has been used to provide all the features. Without extensive rewriting of the code, there is simply no space to include a peak hold feature.

The accuracy of the peak hold would also be in doubt since many race engines simply change RPM too quickly for a reliable measurement, particularly over the 0.6 second update time for your single cylinder 2-stroke engine.

One suggestion would be to set the bargraph to operate over a narrow range of RPM so that peak RPM can be seen as one of the lit LEDs. This will provide a guide as to RPM reached, within the limits set for the bargraph.

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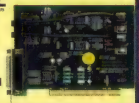

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With this approach, the anode of each diode would connect to the switched side of each coil. The cathodes would be connected together and connected to the collector of the immobiliser transistor.

Suggested diode type would be a BYT12P-1000 rated at 12A and 1000V and fast recovery in a TO-220 package. The diodes are available from Farnell, Cat no. 437-700 for $5.10 each plus GST and delivery. Phone 1300 361 005.

Light dimmer for halogen lamps

I wish to construct the remote controlled version of the lamp dimmer featured in the January and February 2002 of SILICON CHIP. However, I need to make some modifications to the set up for it to work in my particular application.

Firstly, I am controlling two 12V halogen lamps fed via two transformers fed from a standard domestic dimmer control. Can I simply replace the dimmer control with the remote controlled dimmer?

Secondly, I need to mount the infrared sensor off the board some 20 to 30mm away. Will this work satisfactorily? Also would I still need to be shield the infrared sensor and fit the 0.1µF capacitor between the sensor case and the PC board? (T. B., Buderim, Qld).

● The dimmer has not been designed for use with 12V Halogen lamps. To operate successfully it needs a "snubber" network connected across the Triac so that it will turn off properly with the inductive load presented by the step-down transformers.

A suitable snubber network would be a 22Ω 1W resistor connected in series with a 0.1µF 250VAC (class X2) capacitor. This network would be connected between the A1 and A2 terminals of the Triac. Unfortunately, there is no space for these components on the existing PC board.

The IR sensor must not be placed away from the dimmer PC board since it is connected to the 240VAC mains and is therefore live (ie, at 240VAC).

Capacitance meter switch confusion

In the September 1999 issue, an electrolytic capacitance meter was featured which I am currently building in my spare time. I have almost finished and am ready to put it into its case along with all the switches and the rotary dial.

My question is this: in the parts list, a 2-pole 6-position rotary switch is required as a range selector. However, in the range selector in the front display only four positions are used. Is this a typo error, actually requiring a 4-position switch? (A. A., via email).

● The parts list is correct – you set the stop on the switch to set it to four positions. To do this, undo the mounting nut and remove the stop washer and then place it back on to the correct position to provide four positions.

Fuel mixture display sensor wanted

I've built the Fuel Mixture Display kit (September & October 2000) which I brought from Dick Smith Electronics in New Zealand. The kit is going to be used on my hotrod. However, I'm having problems locating the Bosch EGO probe you listed in the kit as being matched to the unit. The local Bosch agent said the part number is incorrect (LSM11 , 0258104002). Is the number correct or was there a mistake?

Even if you can tell me what type of car the above probe is from it would be helpful. (J. B., Stratford, NZ).

● The Bosch type number is correct. It is a sensor generally used for sensing exhaust smoke stacks, not necessarily in the automotive industry.

The sensor can be purchased from Farnell (NZ 649 357 0646) but it is cheaper to get an EGO sensor from a wreckers such as used in Ford and

Single phase & 3-phase – what do they mean?

Could please explain single and 3-phase? I have been informed during my search that 3-phase is only a name used by industry to obtain dollar energy discounts; at home, it is less costly to run an electric stove from a power point than its designated circuit attachments; and you use less power with an arc welder if you use high amp settings!

Clearly, these claims are ridiculous and I found it hard to keep a straight face. Give me something nice and technical to really make me think. (R. L., Coolbellup, WA).

● Many books have been written on this subject and you should find a few in your local library. In brief, all power stations around the world generate electricity from alternators which produce 3-phase power. The power comes out of the alternator in three lines (conductors), each of which is a sinewave at 50Hz or 60Hz. The difference between successive phases is 120°; three phases make up 360°.

Electricity is distributed all over the country as high-voltage 3-phase. That is why all high voltage towers always have three power lines. The same system is used in your street and typically each house is connected between one of the phases (ie, 240VAC) and neutral. Only when a house has a heavy power appliance such as an instantaneous water heater or pool heater is it normal for three phases to be connected. In those cases, you will find that the house has four power lines; ie, three phase lines (each at 240V) and neutral.

Many people (including electricians) are confused about 3-phase electricity and cannot understand how there can be 415VAC between each phase line but only 240V between each phase and neutral. The only way to understand the topic is to delve into the textbooks. If sufficient other readers are interested, we may do a short series of articles on the subject.

Holden 6-cylinder cars. The Fuel Mixture Display operates successfully with most automotive sensors.

How to bridge a stereo amplifier

I recently bought a 185W/channel kit stereo amplifier from Jaycar Electronics and I am wondering whether it is bridgeable? If so, how is it connected to the speakers and input and what is the output? (J. S., via email).

● You need an op amp adaptor circuit to bridge the two power amplifiers. We published a suitable circuit, although with no PC board, in the February 1988 issue. We can supply a photostat copy of the article for $7.70 including postage.

Ceiling fans run too fast

Many of the houses I have lived/live in have the toilet ceiling fan connected to the toilet light. The wiring to the switch is often inaccessible so alterations are difficult. In the ceiling, the fan plugs into a socket which is wired to the ceiling light.

There are several problems with this arrangement. The fan is not always required for a toilet visit. When the fan is required, it should continue running for a delay time after the visit. Most ceiling fans run too fast/noisy for the toilet and require some form of speed control.

This is what I propose: the original switch still controls the fan/light circuit but is left on if the fan is required. The light turns on/off immediately with the switch. If the light is turned on, there is a delay of about two minutes before the fan operates (this allows a short toilet visit with no fan).

If the switch is turned off, both the light and fan turn off. If the switch is left on, both the light and fan stay on for a delay of about 15 minutes (the fan/light will run for a period after the visit). If the fan/light have cut out after the time delay, the circuit is reset by turning the switch off then on. The fan has preset speed control. The components would be mounted in a box in the ceiling. (A. D., Erskine, WA).

● Unfortunately, your fan control concept involves control of both the light and fan, as well as speed control for the fan. While it is certainly feasible as an electronic circuit, the simplest approach would be to add in a fan switch (ie, separate circuit to the fan) with inbuilt time delay and add a resistor or capacitor in series with the fan to reduce its speed. In this way, you could turn on the fan when required and its noise would be reduced anyway because of the reduction in speed.

LEDs flashing on mixture meter

I have constructed the Fuel Mixture Display kit described in the "EFI Tech Special" The kit is not functioning how it should with lights buzzing left and right on idle at normal temperature. The red light stays on all the time. If I adjust the trimpot, the yellow light shows. What could be the fault in this situation? (E. B., via email).

● There isn't too much that can go wrong with this kit. It seems that the IC is driving the LEDs from one extreme to the other as the yellow (rich) and red (lean) ones light with variation of VR1.

Check that there are no shorts between tracks on the PC board, by scraping between tracks with a sharp knife. Also check that there are no solder bridges between pins on IC1 by comparing the published pattern with the underside of your board.

It is possible that the input at pin 5 has been damaged. It can be protected by connecting a .01μF capacitor between pins 5 & 4 and using a 100kΩ resistor in series with the input from the oxygen sensor.

Simple train controller wanted

I was wondering whether you knew of a circuit that would work as a speed controller on my train motor. The motor is from one of those old electric walk-behind lawn mowers with a roller to drive it and tubular blades. I have the train running from the smallest car battery you can get and that runs it for about 50 to 60 minutes before it starts to go flat. (J. P., via email).

● Have a look at the Li'l Pulser train control in the February 2001 issue. Depending on how much current you need to supply, you may have to use a bigger FET, bigger relay and a bigger heatsink.

Speed Alarm won't limit car speed

Could the PIC-based Speed Alarm described in the November & December 1999 issues be used to limit a car's speed in a similar way to the PIC Tachometer described in April 2000, which limits the revs via an immobiliser?

I guess my question really is "Can the Speed Alarm be interfaced with the immobiliser circuit with only software revision?" Your help would be appreciated. (S. A., via email).

- The Speed Alarm is not suitable to actually control the speed of the car. For this you need a cruise control as it requires a means to manipulate the air flow to the engine via the carburettor or throttle body in a fuel injected car.

Enhanced plugpack power supply

I remember a very useful circuit that I'm sure I saw in SILICON CHIP magazine but I've looked all though the circuit listings and can't find it. It was a simple circuit to reduce mains hum when you're using a "plugpack" power supply with any sort of audio device. I thought it was in the "Circuit Notebook" section. (M. C., Eight Mile Plains, Qld).

- The article was in the December 1998 issue, entitled: "A Regulated 12V DC plugpack".

Universal battery charger differences

I am trying to find out what the differences are between the original and Mk.2 versions of the Universal Battery Charger. Can you help? (C. S., via email).

- The main differences are that the Mk.2 version has facility to charge Lithium-Ion batteries and there are more voltage ranges available for charging Nicad and NiMH batteries. Also the tendency for the Mk.1 charger to prematurely terminate charging for older batteries has been corrected.

You can upgrade the Mk.1 version to the Mk.2 version by transferring the components from the old board to the new PC board. This PC board is coded 14302982 and is available from RCS Radio Pty Ltd. Phone (02) 9738 0330.

Hardware items such as the case, the transformer, mains and battery connection wiring, heatsink and rectifier are unchanged. The front panel is changed slightly to accommodate the extra battery type and ranges. Of course, it is not necessary to include all the extra voltage ranges provided by the Mk.2 version or include the Li-Ion selection.

Main parts changes are the addition of a 2-pole 4-position rotary switch in place of the DPDT toggle switch used for S3 and some resistor changes. SC

Notes & Errata

PC-Controlled Mains Switch, September 2001: to avoid the possibility of electric shock from contact with the power plug's pins when it is disconnected, a 100kΩ 0.5W resistor should be connected across the Varistor. This will discharge the 0.1μF 250VAC capacitor.

Also, to improve the voltage isolation of the PC tracks around the optocoupler, it is recommended that neutral cure silicone caulking compound be applied to pins 4-6 of OPTO1 and the nearby component pads.

Pardy Lites, December 2001: the resistor following D1 should be 820Ω instead of 4.7kΩ. Both the circuit on page 68 and the PC board on page 69 have this error.

Audio/Video Distribution Amplifier, November 2001: there is an error in the underside copper pattern for the PC board which causes both audio outputs from the fourth socket pair from the right-hand end (looking from the rear) to deliver the R channel output signal.

The problem can be fixed fairly easily. First, remove the PC board assembly from the case and turn it upside down with the output connectors on the top. Then locate the fourth audio output pair from the left and verify that the pads at the lower ends of the two output series resistors (originally 47kΩ, now 1kΩ) both have tracks connecting them to the upper 'R' signal line track – unlike all the other output pairs. Cut the track on the right and, using a short length of tinned copper wire, connect the resistor pad to the lower 'L' signal line track instead.

Solar Power Battery Charger, March 2002: the MJE2955 labelling for Q2 and Q3 on the overlay diagram on page 85 is incorrect. They should be labelled MTP2955. (Note that an MTP2955 is a P-channel Mosfet while a MJE2955 is a bipolar power transistor). The circuit and parts list are correct.

In addition, the parts list incorrectly specifies a 4011 for IC1; it should in fact be a 4093 quad Schmitt trigger, as shown on the parts overlay diagram.

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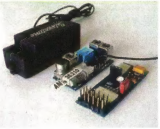

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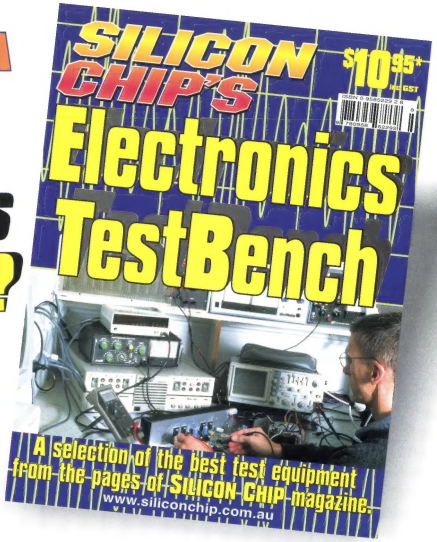

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